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THE NATURAL HISTORY OF BUCKINGHAM PALACE GARDEN, LONDON. PART 1

Supplement to
The London Naturalist number 78: 1999

Edited by Colin W. Plant

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THE NATURAL HISTORY OF BUCKINGHAM PALACE GARDEN, LONDON, PART I

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for the year 1999

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Introduction to the Survey

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Buckingham Palace Garden represents something unique in Britain. Here, in the heart of one of the most urban areas of Europe, surrounded by traffic and a very large number of people, lie just over 16 hectares (39.6 acres) of greenery which remain largely secluded, other than briefly each summer during the Garden Parties.

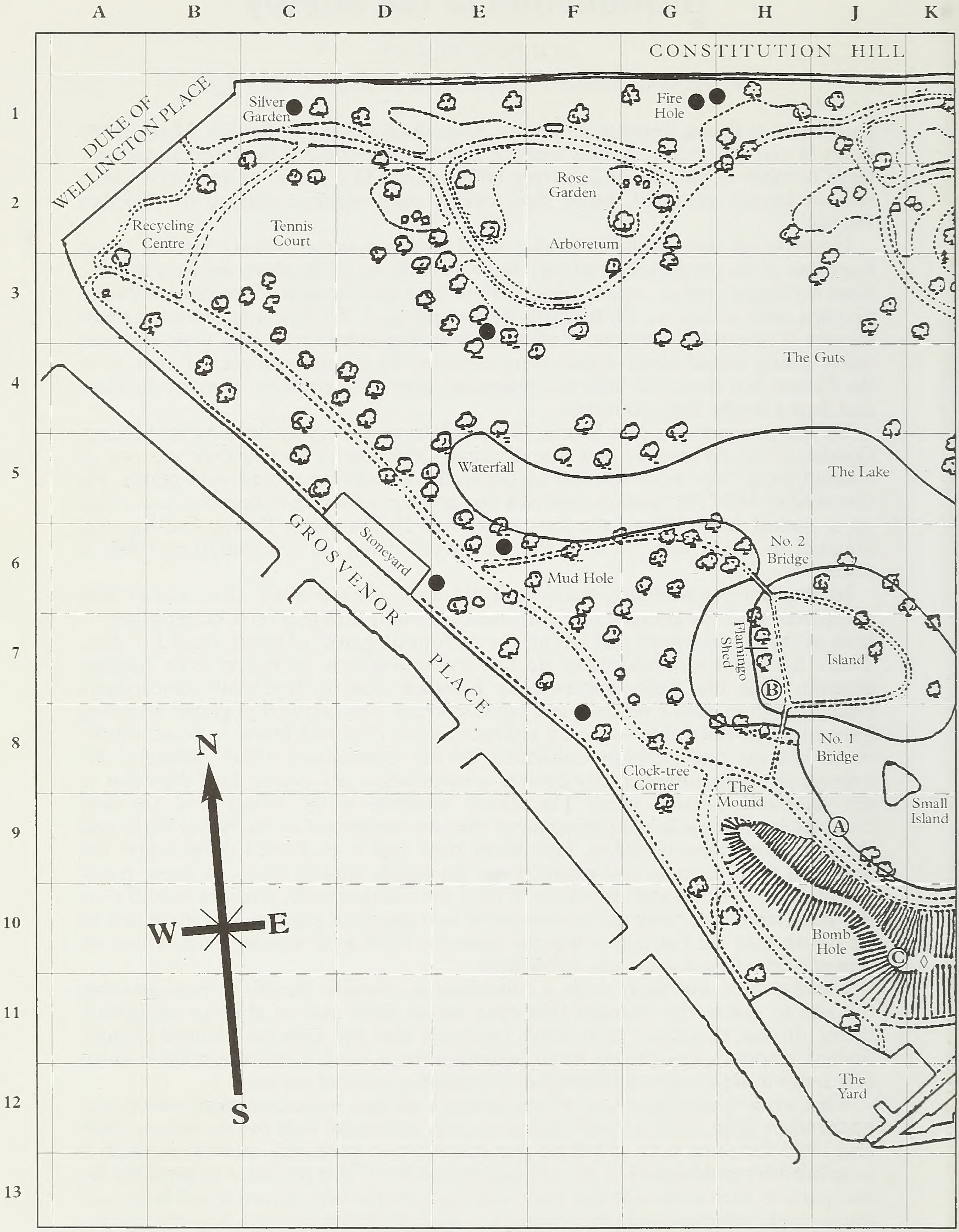
However, in spite of the existence of a London Natural History Society (or at least one of its precursor societies) since as early as 1858, there appears to have been no formal report on any aspect of the flora and fauna in Buckingham Palace Garden until as late as 1926 when, in the spring, F. W. Edwards recorded three species of mosquito (Diptera: Culicidae) breeding in tree rot-holes. Over the next thirty years, casual observations were reported by a small number of visitors to the Palace, but these did little to present any sort of impression of what the flora and fauna might truly comprise.

Yet the present idea of a formal flora and fauna survey at Buckingham Palace Garden is not an entirely new one. During 1956, David McClintock was one of a select party who were allowed access to the Garden to record wild plants. He returned in 1957 for another visit and was given permission to organise recording on a formal basis. Thus, the first survey of Buckingham Palace Garden was initiated in 1960, with most of the field work being carried out from 1961 to 1963.

In the thirty-something years to 1995 that elapsed since that survey was completed and the present one commenced, many changes have taken place — both in the Garden itself and within the surrounding area of the heart of London. There has been a considerable decline in atmospheric pollution from sulphur dioxide. This has been matched by a steady rise in levels of atmospheric pollutants from motor vehicles and other sources. The concept of global warming introduces considerable scope for changes to our flora and fauna — some subtle, some less so, and perhaps enhanced by the 'heat-island effect' whereby the average air temperature in city centres is maintained at a higher level than that of the surrounding rural areas. The steady advance of the urban area has now completely surrounded the green areas that are comprised of the Royal Parks and Buckingham Palace Garden. This must have had a profound effect upon the ability of both animals and plants, even the highly mobile birds, to move freely between the Garden and elsewhere. Within the Garden itself, changes in staff over the years have inevitably led to changes in management regimes and there can be no doubt that the Garden is not the same in 1999 as it was in 1964, when the report of the first survey was published.

Clearly, there was likely to be a considerable scientific benefit in re-examining the site to assess the changes that have taken place and to attempt to explain them. It was, therefore, with some eagerness that the London Natural History Society responded positively to an invitation from Mark Lane, the present Head Gardener at Buckingham Palace, to coordinate a second survey.

This work is the first part of the product of that re-examination, which was undertaken from 1995 to 1997 inclusive, with additional field survey during 1998 and 1999 for some taxa. It will be presented in two parts, the second of which is scheduled for publication in the late autumn of 2001. It is intended to produce the two parts in such a manner that they may have their covers removed and be bound into a single volume should their owners so wish. With this in mind, lists of contents, acknowledgements and other such matter are absent from this first part and will be produced in the next one. However, in this introductory text it is considered important to mention, but briefly, the manner in which the work was organised.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DUKE OF WELLINGTON PLACE
Silver Garden
Fire Hole
Rose Garden
Recycling Centre
Tennis Court
Arboretum
The Guts
Waterfall
The Lake
Stoneyard
GROSVENOR PLACE
No. 2 Bridge
Mud Hole
Flamingo Shed
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Clock-tree Corner
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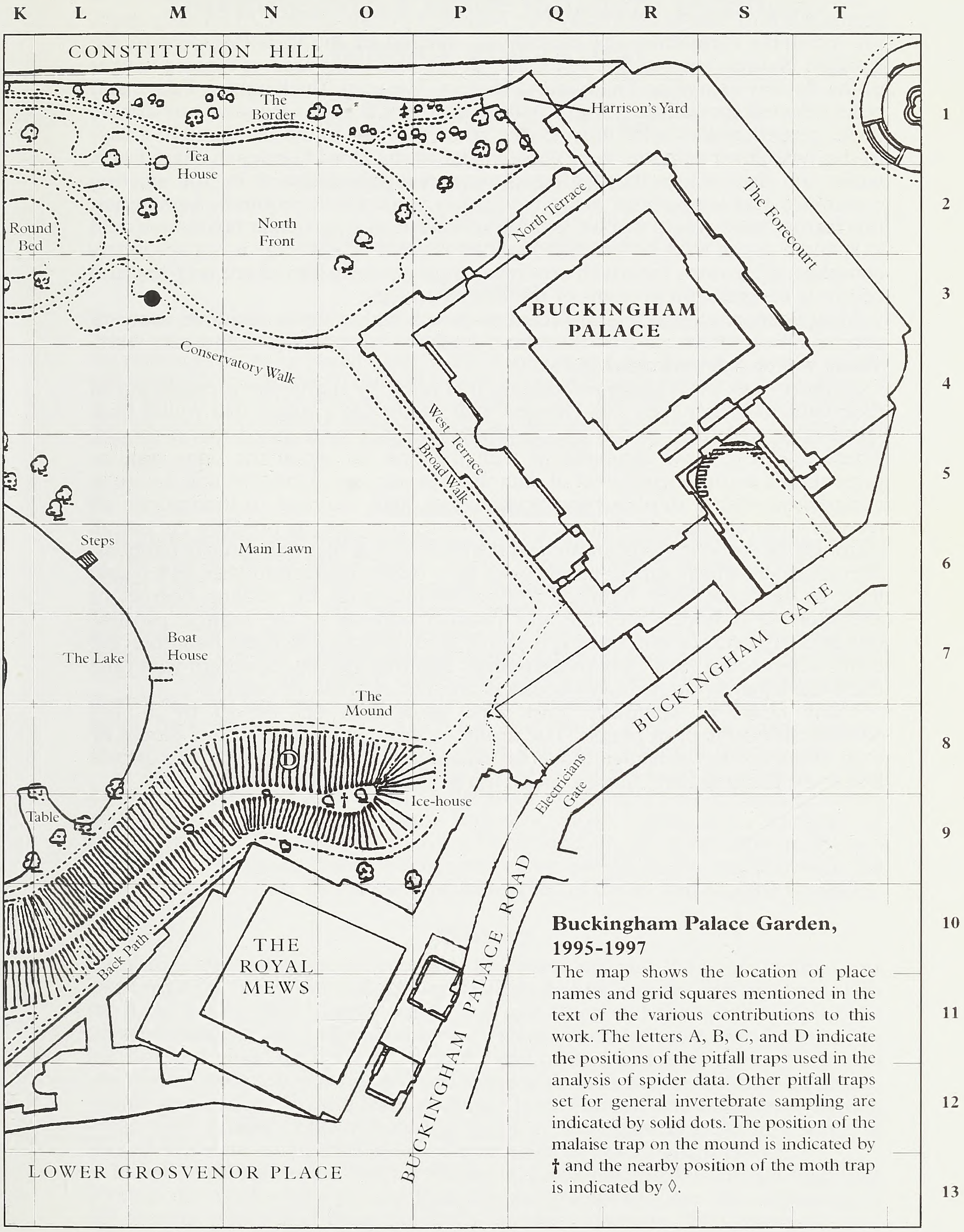

Buckingham Palace Garden, 1995-1997

The map shows the location of place names and grid squares mentioned in the text of the various contributions to this work. The letters A, B, C, and D indicate the positions of the pitfall traps used in the analysis of spider data. Other pitfall traps set for general invertebrate sampling are indicated by solid dots. The position of the malaise trap on the mound is indicated by † and the nearby position of the moth trap is indicated by ◊.

It clearly would have been impractical, if not impolite, to put large numbers of naturalists into what is essentially Her Majesty's private garden. At an early stage, the inevitable committee was established, chaired by the then President of the London Natural History Society, Colin Bowlt, and composed of representatives of the Society as well as The Natural History Museum, Buckingham Palace and other selected specialists. A list of names of potential field surveyors was drawn; these 'core recorders' were most kindly granted access to the Garden. On a day-to-day basis, their activities were coordinated by the Head Gardener, Mark Lane, whilst the data which they gathered were regularly assessed by the steering committee and suggestions made for further work where required. Sometimes, this further work would involve inviting specialists in a particular taxonomic field to spend a day in the Garden. Although the taxonomic coverage is not absolutely complete, the groups for which coverage could not be achieved are very few and relatively insignificant in terms of the overall ecology.

Identification of material collected was undertaken by a veritable army of people, all of whom gave of their time freely to support this important work. These will be acknowledged in Part 2.

Authors have been given a relatively free hand by me in the presentation of their data, although each was charged with producing a paper that would both stand alone and fit in to this overall report and they were asked that it should, where practical, draw comparisons with the first survey, at the same time as presenting a comprehensive set of data that our successors may be able to use in comparison with a third survey. Species lists were required to incorporate all records from all time, so that they could be as complete as possible. As overall editor of the work, it has been my responsibility to see that this actually happens. All the papers which appear in this work have been subjected to peer review and have, in all cases, been returned to authors thereafter for varying degrees of alteration. It is hoped that the end product adheres to the highest possible standard of accuracy but, since it is widely acknowledged in publishing that 'the editor's decision is final', any shortcomings that may become apparent with time must rest squarely on my own shoulders and not on those of others.

Many hours of voluntary work have gone into this report by a very considerable number of people. The results of this complicated labour should be both of interest to the reader and a permanent and accurate record of the natural history of Buckingham Palace Garden at the close of the twentieth century.

Buckingham Palace Garden: geology, history and layout

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Abstract

Buckingham Palace Garden is an area of Central London that has gone through some major transformations during the course of its history and all of these have contributed to the present structure and habitat seen today. A summary of the relevant aspects of the soil and other geological factors, historical aspects, layout and management policies is provided as an introduction to the in-depth papers on specific taxa that follow in this volume. Wildlife habitats currently extant are discussed briefly and it is concluded that the desire to maintain a haven for wildlife has been reconciled admirably with the formal requirements for the Garden.

Geology and soil

The immediately underlying natural geology at Buckingham Palace Garden is one of the geologically recent Thames Terrace Gravels, which overlie London Clay (Plant 1994). The soils of the Garden originally derive from the wet fields that used to cover the area, but have been altered, drained and added to with rubble and soils from a variety of sources over the years, in addition to manuring and mulching. A few soil samples examined during the previous survey (Avery 1964) were of a sandy loam texture containing 13–19 per cent clay but with organic matter ranging between 8 and 16 per cent. Measured acidity varied, even on the lawns, between pH values of 3.5 and 6.4. Peat blocks, used on the edges of some of the flower beds, can be expected to have enhanced acidity in their vicinity.

In the south-east corner, screening the Royal Mews from the Palace, is The Mound, constructed in the mid 1820s from imported London building debris and covered with a sandy loam, and now incorporating fine examples of fabricated stone (Pulhamite) outcrops. These, and similar stone-work on the two bridges to the island, brick-pointing and other cement-work, together with the Portland Stone of the Palace itself, provide some of the limited alkaline situations.

History

Until well into the sixteenth century, the Palace site and the surrounding areas were swampy, being watered, and quite often flooded, by the Tyburn River. This ran from Hyde Park Corner across the east front and the south wing of the present Palace. Lord Arlington put the Tyburn into a conduit, but the area was not finally drained until 1824. Up to the end of the eighteenth century this land was open country. It was divided into areas with such names as Adam's Pasture, Upper and Lower Crow Fields, Goring Great Garden and Mulberry Garden Field, with smaller fields in between. Early in the eighteenth Century some of these fields were amalgamated into the grounds of Buckingham House.

In 1608/9, King James I had his Mulberry Garden planted on no less than four acres to the north of the present Palace in an attempt to foster the cultivation of silk worms, which had been successful on the Continent. This expensive and troubled project was, for various reasons, a failure.

In 1677, it was reported that there was a flower garden, dwarf tree garden, wilderness grove, bowling green, very extensive orange houses, also a terrace walk and a mount set with trees, a kitchen garden and a pond. Sir John Sheffield, later the Duke of Buckingham, bought the site in 1702. Changes to the Gardens were designed by Henry Wise (1653–1738), of London and Wise, based in Brompton. Something like £1,000 was spent on levelling the ground and a further £1,000 on plants by the end of 1702. In 1709, Buckingham wrote a long description of the Gardens, mentioning various plantings and features including a long tree-lined canal.

All this time there seems not to have been any considerable fence around the Garden, but a lease of 1716 refers to a fence and one in 1745 to a wall. There is a reference in 1746 to the park wall to Buckingham House and an engraving after Chatelain of 1748 shows an unmistakable line of railings, with which grew a boundary of trees round the garden. In maps of 1761 and 1818, there appears an oval pond some sixty by twenty feet, situated towards the western boundary, with a much smaller one just to the north, but these were gone by 1821. In 1817, the garden was described as consisting merely of a gravel walk shaded by trees with a spacious and unadorned area in the centre.

King George IV commissioned William Townsend Aiton to landscape the Garden and he was still working at it when Queen Victoria came to the throne in 1837. In fact he held the contract for maintenance and replanting from 1826 until 1838. Nash offered Aiton's preliminary estimate for the laying out of the Garden in 1825 at £22,290 although there is no record whether this was accepted. Again in the same year, there had been a Supplementary Estimate that included the 'earthworks in the garden'. By 1827/8, the lake had been excavated and The Mound (see map, pages 2–3) constructed, being planted with trees and shrubs in great quantity. The mound was primarily made to conceal from the windows of the Palace the view of the recently erected stables. Some of the excavations from the lake might well have gone into forming The Mound, but although they cover a similar area, The Mound is substantially higher than the lake is deep confirming the importation of soil. Planting went on vigorously until at least 1838, and indeed has continued, intermittently, ever since. A Small Mound was constructed in 1860 at the behest of Prince Albert so as to protect the Queen from being overlooked from the then new Palace Hotel.

Soil and other materials have been imported on numerous other occasions. In 1833, the purchase of 500 cubic yards of gravel from Hyde Park was authorized, for an unstated purpose; the inference is that another 2,000–3,000 cubic yards came in the following year. In 1841, 150 cubic yards came from Shirley Common, some from Norwood and 300 cubic yards from Kensington Gardens — 'for the border'. In the winter of 1905, 1,500 cubic yards of soil excavated from the Queen Victoria Memorial were used to top dress the lawns and the King agreed that it should be carried out, even though it might disfigure them for a while. When the Cascade was built in 1961, 5,000 turves came from Essex and 2,500 cubic yards of soil came from Hyde Park, as well as topsoil from Kent.

In 1840, the Garden consisted of a spacious lawn and groups of trees 'many of great magnitude especially elms', pre-dating Aiton's plantings. At much the same time, the Queen referred to 'limes and their shade'. However, a report in the same year stated 'these gardens are destitute of the customary appearance of a flower garden'. Consequently, proposals were made for beds to be filled with plants that flower at different times. In December 1840, Prince Albert arranged for a gravel walk to be made along the top of The Mound with connecting walks in different directions, as well as 'across the island and the headland on the north side of the island', about 1,000 metres (1,100 yards) in all. These no longer exist, having been turfed over.

Layout

William Townsend Aiton's original layout is still very much in evidence. Little has changed to the overall designs of the paths, mound, lake or grass areas since 1825.

His, and subsequent, plantings of London plane have matured and become the dominant trees in the Garden. The numerous, aged, holly bushes and the later plantings of camellias and rhododendrons, provide a good amount of evergreen cover. Some changes have taken place, probably the most notable being the loss of a great number of elm trees and the demolition of the Small Mound.

The Garden maintains an open and rather park-like appearance, due mostly to their size and maturity. Large and flourishing shrub borders are strategically placed to obscure corners and to invite investigation. Striking vistas can give the impression of being in the country as well as making the Garden appear even larger. The Garden is screened from the outside by many mature trees; London plane, sycamore, common ash, false acacia and oaks which filter the noise and pollution of the surrounding busy roads.

The area of the Garden is 16.015 hectares (39.57 acres). The greater part is made up of mown lawn, notably the Main Lawn, at about two hectares (4.95 acres), extending from the West Terrace to The Lake and used up to six times a year for the Garden Parties. It is also acts as a landing pad for helicopters. Another considerable stretch of lawn extends through the centre of the Garden towards the Tennis Court and beyond.

The Garden is mostly level, but rapidly rises 7.5 metres from the tennis court towards the north end, corresponding to the rise in Constitution Hill and Grosvenor Place. The stout walls, surmounted by *chevaux-de-frise*, are almost unseen from the inside, where the soft landscaping has all but hidden its stark appearance.

There is no natural water. The sinuous, man-made lake of 1.56 hectares (3.86 acres), with a depth of no more than 1.5 metres, lies towards the south-east of the Garden. It incorporates a recently installed waterfall (1991) that recirculates the water. Two bridges connect the larger island in the lake. To the south side is another smaller island.

The Mound, some 8.6 metres at its highest point, runs along the south of the Garden. It serves well its original purpose of hiding the view of the Royal Mews from the Palace. At its eastern extremity is a large, long-disused Ice House.

Habitats

A high-flying bird would see that Buckingham Palace Gardens, together with Green Park, from which it is separated by the tree-lined Constitution Hill, form part of a chain of large parks, separated only by roads. This green expanse stretches from Kensington Gardens in the north-west to St James's Park in the south-east. Buckingham Palace Garden differs in being hidden behind a high, brick wall and therefore not subject to disturbance and pressure from the public.

The composition of the Garden provides a mixed and varied selection of habitats. The large, wide shrub borders can be regarded as a domesticated form of scrub habitat. These are made up of rhododendrons, camellias and azaleas with occasional plantings of birch, ornamental apple and non-native species, providing suitable nesting-sites and safe cover for birds, mice and other creatures.

The Lake accommodates the captive bird collection and the seasonal migrants, as well as a wealth of aquatic animal life. Water movement from the waterfall is slow, but the quality is sufficiently good to support several species of fish, though submerged aquatic plants are very limited. The soft, wet edges and associated vegetation provide a variety of habitats for invertebrates and some bird species.

Within the larger habitats occur micro-habitats, just sufficient in size to provide for the needs of small organisms. For example, bark from the Palace trees, including planes, were found to support certain myxomycetes, and some small species of fungi were growing on fallen nuts, acorns and leaves. The requirements of many small invertebrates, mosses, etc., are relatively simple, provided that the climate (including air quality) is acceptable. Such micro-habitats often depend, of course, on the larger habitats. An example of this was a single record of the moss *Dicranoweisia cirrata* found growing on an old weeping willow *Salix* x *sepulchralis* var. *chrysochoma*. When the tree was felled, the moss became extinct in the Gardens. This is an example of the vulnerability of small populations.

The average temperatures in central London are slightly higher than in surrounding rural areas. Over a long period, the average temperature at Kew, Surrey was 10.2°C, whilst at St James's Park, adjoining Buckingham Palace, it was 10.7°C (Kent 1975). The difference between central London and the continually built-up area averages about 1.5°C (Burton 1983). This reduces somewhat the risk of frost damage. The rainfall is measured daily in the Garden, but does not differ significantly from the rest of central London.

Management policies

The vigorous activities of the gardeners have many effects and increased mechanization (since the last survey, from 1961 to 1963), has speeded up the various aspects of garden maintenance, with compact tractors and trailers replacing brome trucks.

There are currently two regimes for the grassland management in the Garden; the wilder areas are cut only twice a year and the more ornamental lawns are cut weekly throughout the growing season. The first provides home to many wild plants and naturalized bulbs and the second a perfect home for the famous chamomile *Chamaemelum nobile.*

The general policy in the Gardens is to use the minimum quantity and variety of chemicals necessary and to maintain full records of usage. There is localised spraying for greenfly, black spot and mildew in the Rose Garden and some control for slugs on The Border. Weed growth can be a problem in gravel paths and so these are sprayed when necessary. Weeds elsewhere are dealt with manually. Fertilizers are used only on the ornamental lawns and shrubberies.

All of the annual leaf-fall, as well as the grass clippings, are collected and transported to the Recycling Centre within the Garden for composting. All branches and small logs are chipped and disposed of in the same way. This composted material is then used around the Garden as mulch on the shrub borders. This is a relatively recent change to the waste management regime. Before 1991, all green waste was sent out of the Garden and very little mulching was done in the borders. Well-rotted farmyard manure is brought in annually to mulch the roses and magnolias and occasionally other mulches are imported for specific tasks, such as ornamental bark for woodland footpaths.

It would not be possible to sustain the plantings if irrigation was not used and the borders and some grass areas are regularly irrigated during the drier months. This provides some small, artificially wet areas and sites.

Conclusions

Despite all the varied artificial factors which have been at work for so long in the Garden, the ecological successions, food-chains and all the natural cause-and-effect in the wild are always striving to assert themselves. But for the extremely active gardening, the place would soon revert to an even richer haven for wildlife, but this is not generally compatible with the requirements of the Garden. Fortunately, the two opposing factors are well reconciled.

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Myxomycetes in Buckingham Palace Garden

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Abstract

Sixty-eight species of slime moulds have been recorded from Buckingham Palace Garden, thirty-three from the bark of living trees, notably *Platanus*. Several of these are rare species and represent new records for the London Area.

Introduction

Ornamental Gardens in the centre of major cities are, at first sight, unlikely habitats for the plasmodial slime moulds, or Myxomycetes. The first survey of Buckingham Palace Garden (McClintock 1964), revealed a single, very common species, *Fuligo septica*. During the current survey, myxomycetes were collected in the field during regular visits, usually weekly, by Peter Holland and Alick Henrici, while recording 'true' fungi. A single visit in January 1997 by the writer enabled the collection of twenty-eight bark samples from twenty-four species of tree in the Garden. These were subsequently cultured in moist chambers and produced thirty-three species of myxomycete and one acrasian, *Pocheina rosea*. Most of these species are typically inhabitants of the bark of living trees, corticoles, but a few are more usually found on rotten wood and in leaf litter — casual spores may have taken advantage of the culture conditions to develop and fruit.

A total of sixty-eight species of slime moulds is now recorded (a gain of sixty-seven species, with no losses). This compares well with the 356 species recorded from the British Isles. Considering the limited range of micro-habitats available, notably the scarcity of stumps, rotting trunks and large fallen branches, it is unlikely that this number will be increased significantly. The list is surprisingly large and, in addition, includes some nationally very rare species. Of these *Comatricha ellae* was the third record from England, *Licea pygmaea* had not previously been found in the south of England and *Paradiacheopsis microcarpa* was hitherto known only from north Wales and Cheshire. *Licea biforis* is a species which appears to be extending its range in Britain and is now common in the London Area. As well as on tree bark, it is also recorded from the Garden, on old herbaceous stems maintained in a moist chamber. This is a new habitat for the species. *L. operculata* is becoming of frequent occurrence and is now known from other parts of central London (Ing 1998). *L. scyphoides* is more usually found in Atlantic woodland, but is known from Sussex and, since the Survey, from Holland Park, London. *L. tenera* is a rare and misunderstood species, with few records anywhere, although it was recorded from Epping Forest in 1898. Of the bark species, seventeen are new published records for the London area. In contrast, those Myxomycetes found on wood and herbaceous litter are all common species, characteristic of woodland and grassland throughout southern Britain.

The interest of the list is achieved partly by a sustained collecting effort and partly by the use of specialized techniques, such as moist chamber culture. The range of habitats present allows species characteristic of woodland, grassland and cultivated land to find suitable niches. The wide range of tree species is of greater significance, notably the presence of large specimens of London plane, *Platanus* x *hispanica*. Before this survey, plane bark was not considered to be particularly productive. In the Garden, sixteen species developed on the bark of London plane, more than twice the number on any other genus of trees. A similar result has been shown in many central London parks (Ing 1998).

The situation of the Garden, surrounded by busy roads and a densely populated city, is not promising. The abundance of Myxomycetes, although they are not known to be especially sensitive, suggests that pollution levels are dropping significantly. The high perimeter walls may well be reducing the impact of pollution from road traffic. Above all, the abundance of roosting birds may be linked to the enrichment of the bark with nitrogenous bases from their droppings and the consequent neutralising of acid deposition. The management of the Garden is maintaining and increasing the diversity of micro-habitats. The value of non-native trees as substrates for bark Myxomycetes is well shown, in that twenty species were found on native trees and twenty-nine on exotics.

List of Myxomycota recorded in Buckingham Palace Garden

The nomenclature in this list, and the arrangement of the species, follows Ing (1999). The single species recorded in both the previous and the present surveys is indicated by an asterisk (*). Herbarium material is held in Herb. P.C. Holland and in Herb. B. Ing; all these voucher specimens are destined to be deposited in Herb. Kew. VC 21 means Vice-county 21, Middlesex.

MYXOMYCOTA

ACRASIOMYCETES

ACRASIDALES

Acrasidaceae

Pocheina rosea (Cienk.)Loeblich & Tappin

On bark of *Castanea*, *Pinus* and *Populus*. This acrasian is usually the first slime mould to appear when bark is placed in moist chamber culture, often after 24 hours. It is characteristic of the most naturally acid, or acidified bark, but is not persistent so may be overlooked in cultures if they are not examined daily. It is widespread on urban bark.

MYXOMYCETES

ECHINOSTELIALES

Echinosteliaceae

Echinostelium apitectum Whitney

On bark of *Pinus* and *Robinia*. A widespread and frequent species, similar to and sometimes confused with *E. colliculosum*. This is a new record for Inner London and VC 21.

E. brooksii Whitney

On bark of *Aesculus*. A widespread and frequent species on isolated, rather acid-barked trees, not common within forests but very characteristic of park trees. New to Inner London and VC 21.

E. colliculosum Whitney & Keller

On bark of *Platanus*, *Populus*, *Quercus* and *Salix*. Another common and widespread species, although it may be confused with *E. apitectum*, characteristic of moister bark, which is often less acid than that tolerated by other species. New to Inner London and VC 21.

E. corynophorum Whitney

On bark of *Acer*, *Eucalyptus*, *Quercus* and *Taxus*. A widespread and but less common species, frequent on eucalypts. New to Inner London and VC 21.

E. fragile Nann.-Bremek.

On bark of *Platanus*, *Robinia* and *Salix*. Frequent and widespread, especially on isolated trees, perhaps with less-acid bark than those favoured by *E. brooksii*.

E. minutum de Bary

On bark of *Aesculus*, *Fraxinus*, *Platanus* and *Taxus* and on fallen *Rhododendron* leaf. Common and widespread, not showing any tree preferences and occasionally, as here, developing on litter; usually develops later in culture than other species of the genus.

LICEALES

Liceaceae

Licea biforis Morgan

On bark of *Platanus* and *Salix* and on dead stems of *Eupatorium*. Frequent and widespread in southern and western Britain, but until now not associated with urban trees. New to Inner London.

L. denudescens Keller & Brooks
On bark of *Aesculus*. A frequent but inconspicuous species characterised by the deciduous outer layer of the sporangium wall; mostly associated with lichens on bark but may also occur, as here, with the green alga *Desmococcus olivaceus*. New to inner London and VC 21.

L. kleistobolus Martin
On bark of *Aesculus*, *Crataegus*, *Malus*, *Pinus*, *Platanus*, *Populus*, *Quercus*, *Salix* and *Taxus*. Another common and widespread species, typical of thin, acid bark, especially of conifers and often found on quite young trees, shrubs and climbers. New to inner London.

L. marginata Nann.-Bremek.
On bark of *Castanea*, *Fraxinus* and *Platanus*. Widespread but not common, although when it does occur it may be in such numbers as to completely cover the surface of the bark, as is the case with the material from the Garden. Usually found on moisture retentive, less-acid, bark. New to Inner London.

L. minima Fr.
On bark of *Salix*. A common and widespread species on acid bark and also on rotten wood of conifers.

L. operculata (Wingate)Martin
On bark of *Platanus* and *Salix*. Frequent in eastern Britain, usually on thick-barked trees, especially if the bark is eutrophicated with bird droppings. New to Inner London and VC 21, but since the survey found to be widespread in central London.

L. parasitica (Zukal)Martin
On bark of *Fraxinus*, *Platanus*, *Salix* and *Sophora*. The commonest species on bark, especially if it is moisture-retentive, often associated with mosses and lichens and perhaps less abundant on acid bark. New to Inner London and VC 21.

L. pygmaea (Meylan)B. Ing
On bark of *Platanus*. A rare species on very mature bark; not previously recorded from the south of England but since found in five other parks in central London.

L. scyphoides Keller & Brooks
On bark of *Salix*. A typically Atlantic species, rare in south-east England. New to Inner London and VC 21 but subsequently found in Holland Park.

L. tenera Jahn
On bark of *Taxus*. A rare and misunderstood species, sometimes reported from dung, and then probably a misidentification for a species of *Perichaena*. This is a true bark species and is known from Surrey and Epping Forest but is new to Inner London and VC 21.

L. testudinacea Nann.-Bremek.
On bark of *Platanus*. Widespread but uncommon, usually on thicker, more eutrophic bark than the superficially similar *L. minima*. New to Inner London and VC 21.

Dictydiaethaliaceae

Dictydiaethalium plumbeum (Schum.)Rostaf.
On fallen twigs and branches of *Fraxinus* and *Prunus*. A common and widespread species on fallen wood, especially in the south of England.

Lycogalaceae

Enteridium lycoperdon (Bull.)Farr
On stump of *Sorbus latifolia*. One of the commonest Myxomycetes, especially in spring on dead, standing trees, and often on worked wood in buildings.

Lycogala terrestre Fr.
On stump of *Sorbus latifolia*. The commoner segregate from the *L. epidendrum* complex, very common everywhere on fallen trunks, branches and stumps.

TRICHIALES

Dianemataceae

Calomyxa metallica (Berk.)Nieuwland
On bark of *Crataegus* and on rotten wood. Widespread and frequent, now known to occur widely on *Platanus* in London parks.

Arcyriaceae

Arcyria affinis Rostaf.
On rotten stump. Frequent in southern England, especially on *Fagus*.

A. cinerea (Bull.)Pers.
On bark of *Platanus*, *Robinia* and *Taxus*. A common and widespread species on moist bark and fallen wood, often associated with bryophytes.

A. denudata (L.)Wettst.
On rotten wood. Very common on fallen trunks and stumps, especially of hardwoods.

A. incarnata (Pers.)Pers.
On rotten *Salix* stump. Common everywhere, especially characteristic of fallen *Quercus* branches.

A. pomiformis (Leers)Rostaf.
On bark of *Crataegus*, *Malus*, *Platanus* and *Taxus*. Common and widespread on bark, often drier and more acidic than that supporting *A. cinerea*, also found on fallen branches, but not associated with bryophytes.

Perichaena chrysosperma (Currey)Lister
On bark of *Platanus*. A widespread and frequent species on damp, eutrophic bark in western and northern Britain, much rarer in the south. New to Inner London.

P. depressa Libert
On bark of *Platanus*. Widespread in southern Britain and common on fallen bark, especially of *Fraxinus*, but very uncommon in moist chamber culture. New to Inner London.

P. vermicularis (Schw.)Rostaf.
On fallen *Ilex* twig. An uncommon species of deep leaf litter, especially during the winter months. New to Inner London and VC 21.

Trichiaceae

Metatrichia floriformis (Schw.)Nann.-Bremek.
On rotten wood. One of the commonest species on wet, rotten wood, mostly in secondary woodland, although at the beginning of the century it was regarded as a rarity.

Trichia contorta (Ditm.)Rostaf.
On fallen *Fagus* cupules. A frequent, but variable species on twigs and woody litter, widespread in the London area.

T. flavicoma (Lister)B. Ing
On fallen *Fagus* cupules. An uncommon species of leaf litter. New to VC 21.

T. varia (Pers.)Pers.
On rotten wood. Very common on wet, rotten wood everywhere.

STEMONITALES

Stemonitaceae

Comatricha alta Preuss
On fallen *Betula* trunk. An uncommon species in the London area, as elsewhere.

C. ellae Härkönen
On bark of *Populus*. A rare species, sometimes mistaken for small forms of *C. nigra* which occur on bark. This is the third record from England and the fourth from the United Kingdom. New to VC 21.

C. laxa Rostaf.
On bark of *Quercus* and *Tilia*. A common and widespread species on fallen wood, much less frequent on bark. New to Inner London and VC 21, but subsequently found in three more London parks.

C. nigra (Pers.)Schroet.
On rotten branch of *Sorbus*, and bark of *Pinus*. One of the commonest Myxomycetes anywhere on rotten wood but much less common on bark, although found regularly on that of conifers in mountain woodland!

C. rigidireta Nann.-Bremek.
On bark of *Aesculus*. A rare species which seems to be commoner in central London than in any other part of the British Isles. The Buckingham Palace Garden collection was a new record for Inner London and VC 21, but it has now been found in several other parks around the city.

Enerthenema papillatum (Pers.)Rost.
On fallen branch of *Sorbus*. This is usually a common species on the bark of trees such as *Quercus* and *Pinus*, but it is surprisingly rare in this habitat in the London area, although common on fallen branches.

Lamproderma scintillans (Berk.& Br.)Morgan
In leaf litter. One of the commoner species of this beautiful genus and very characteristic of *Ilex* litter in the London area.

Paradiacheopsis cribrata Nann.-Bremek.
On bark of *Quercus*. Widespread on bark, but less common than *P. fimbriata* or *P. solitaria*. New to Inner London and VC 21.

P. fimbriata (G. Lister & Cran.)Hertel
On bark of *Acer*, *Aesculus*, *Castanea*, *Fraxinus*, *Pinus*, *Platanus*, *Populus*, *Quercus*, *Robinia*, *Salix*, *Sophora* and *Tilia*. The commonest myxomycete on naturally acid or acidified bark and generally abundant on the bark of urban trees, often to the exclusion of all other species; often associated with green algae and lichens.

P. microcarpa (Meylan D.W. Mitchell
On bark of *Pinus*. A rare species of acid bark, hitherto known only from north Wales and Cheshire and, so far, confined to *Pinus* or *Quercus*. New to VC 21.

P. solitaria (Nann.-Bremek.)Nann.-Bremek.
On bark of *Acer*, *Castanea*, *Populus*, *Quercus* and *Tilia*. Common and widespread but usually associated with older woodland in less acid or unpolluted areas. It is one of the species characteristic of ancient forest but is clearly not exclusive. Its presence in the Garden, as in other parts of central London, is an indication of the improvement in air quality in recent years.

Stemonitis axifera (Bull.)Macbr.
On rotten wood. A common and widespread species.

S. fusca Roth
On dead wood. The commonest species of the genus.

Stemonitopsis typhina (Wiggers)Nann.-Bremek.
On stump of *Platanus*. One of the more common species of wet, very rotten wood, especially of broad-leaved trees.

PHYSARALES

Physaraceae

Badhamia foliicola Lister
On bark of *Aesculus*. A species found in three distinct habitats, namely living lawn grasses, grass litter and bark of living trees. It is frequent in all three habitats in the London area.

B. panicea (Fr.)Rostaf.
On rotten stump of *Sorbus latifolia*. Common and widespread, especially on fallen *Fagus* trunks.

B. utricularis (Bull.)Berk.
On *Stereum* on fallen branches. The large yellow plasmodia of this common species are a familiar sight on fruit-bodies of *Stereum* and *Phlebia*, especially on *Fagus* trunks; this is one of the few truly fungivorous species.

Craterium minutum (Leers)Fr.
In litter of *Platanus*, *Pteridium* and grasses. A common species on herbaceous litter, occasionally fruiting on living leaf stalks, especially of *Ranunculus repens*.

Fuligo rufa Pers.
On well-rotted stump. Characteristic of very rotten stumps. Often in places which are exposed to the sun and therefore warmer and drier. Recorded several times around London, but new to VC 21.

**F. septica* (L.)Wiggers var. *flava* (Pers.)R.E.Fr.
On rotten stumps of *Sorbus* and *Platanus*. The very common 'Flowers of Tan' which is, perhaps, the most familiar myxomycete to non-specialists, often looking like scrambled eggs spilt onto a log or stump.

Physarum bitectum G. Lister
In leaf litter. Common in the London area on leaf litter of all kinds, becoming rarer northwards.

P. bivalve Fr.
In moss at the bases of grass clumps. Another common litter species; occasionally fruits directly on the soil or, as here, on mosses and other living plants.

P. cinereum (Batsch)Pers.

On grass and leaf litter. One of the species which is often reported as a 'lawn pest' as its yellow plasmodia and purple-grey sporangia 'look sinister'. It is widespread in the London area and is, of course, harmless.

P. compressum Alb. & Schw.

On bark of *Castanea*. Normally a species occurring in herbaceous waste, such as compost heaps, but not uncommon on bark after several weeks of culture. New to Inner London.

P. pusillum (Berk.& Curt.)G.Lister

On grass litter. Another species with a variety of regular habitats, mostly grass-based, this is found in sand dunes, reed marshes, straw heaps and thatch and also on the bark of living trees.

P. robustum (Lister)Nann.-Bremek.

On fallen branch of *Sorbus aucuparia*. A common and widespread segregate from the very common *P. nutans*, this is a new record for Inner London.

Didymiaceae

Diderma hemisphaericum (Bull.)Hornem.

In damp leaf litter. Characteristic of leaf litter in alder carr and other wet woodlands, this species is quite common in the London area.

Didymium bahiense Gottsberger

In grass litter. This is the commonest segregate from the *D. iridis* complex, found in many types of herbaceous litter. It is common in the London area.

D. clavus (Alb.& Schw.)Rabenh.

On bark of *Platanus*. A widespread and frequent species of forest litter, rarely found in bark cultures, and then only on enriched bark after several weeks. As with many of these 'casual' corticolous species the spores were probably trapped on the bark and were stimulated into growth by the conditions in the moist chamber. While not truly 'bark' species they are part of the local myxobiota and therefore the technique is useful in isolating them.

D. difforme (Pers.)S.F. Gray

In litter of *Eupatorium* and *Ilex*. One of the commonest species on litter of all kinds.

D. megalosporum Berk. & Curt.

In damp herbaceous litter and fallen *Fagus* cupules. Another segregate of *D. iridis*, often found on dung as well as litter; frequent in the London area.

D. melanospermum (Pers.)Macbr.

On fallen *Fagus* cupules. A common species of litter, especially of coniferous needles, but also typical of *Ilex* litter and found on a variety of terrestrial mosses.

D. squamulosum (Alb.& Schw.)Fr.

In grass and leaf litter. One of the commonest litter species, abundant everywhere, especially in the winter months.

Mucilago crustacea Wiggers

Encrusting grass stems. A large species, characteristic of base-rich grassland, common in the London area.

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Lichens (lichen-forming fungi) in Buckingham Palace Garden

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Abstract

Thirty-nine species of lichen-forming fungi are reported from Buckingham Palace Garden; two were reported in a previous survey published in 1964. Of these, seventeen occurred on trees, including several which are particularly sensitive to air pollution by sulphur dioxide (e.g., *Evernia prunastri, Parmelia caperata, P. subaurifera, Ramalina farinacea*). The species now found are consistent with what would be expected from changes in the ambient levels of this pollutant; its mean winter levels have declined from 450 $\mu g\ m^{-3}$ in 1962 to less than 50 $\mu g\ m^{-3}$ in 1987, and are perhaps now close to 30 $\mu g\ m^{-3}$. Several interesting species were also discovered on walls and other built structures (e.g., *Caloplaca decipiens, Physcia dubia, Xanthoria elegans*). Further improvements can be expected provided that sulphur dioxide levels remain at current levels or decrease further.

Introduction

Lichens are a biological and not a systematic group, being mutualistic associations between a fungus and an alga, cyanobacterium, or both. The names applied to lichens are strictly those of the fungal component; the included algae or cyanobacteria have independent scientific names. The classification of lichen-forming fungi is now fully integrated with that of the non-lichenized fungi. The fungi involved are mainly *Ascomycota,* but belong to a variety of orders, many of which include non-lichenized as well as lichen-forming fungi.

It is increasingly common practice for lichenized fungi to be listed with their non-lichenized relatives in species lists. They are treated in a separate contribution here primarily because of the remarkable changes that have taken place in these fungi in Buckingham Palace Garden since the last survey.

For further information on the identification of lichen-forming fungi see Purvis et al. (1992) and on their biology and nature see Hawksworth (1988) and Nash (1996).

This report is based on visits made to Buckingham Palace Garden on 6 December 1995, 7 March 1996, 19 November 1996, 13 March 1997, and 6 March 1998. Different areas of the Garden were examined and good coverage obtained. Surveys were undertaken using a ×10 hand lens and small samples of critical specimens collected for confirmation chemically and/or microscopically. In the case of species on the fabric of buildings and monuments, microscope slides were made in the field for subsequent study. The only areas not studied in detail were the tops of the high-security boundary wall and the roofs of buildings (including the Palace itself). All the mature trees, most of which are individually numbered, were examined and the most interesting revisited on several occasions.

Thirty-nine lichen-forming fungi were discovered during 1995 to 1998. This may seem a small number compared with the 1,653 currently known in Great Britain and Ireland (Coppins, Hawksworth & Rose in press), but is a remarkable increase from the two recorded in the previous survey by Dr F. Rose (McClintock 1964). Lichens are particularly sensitive to sulphur dioxide air pollution, and amelioration in its levels are the primary cause of this dramatic change which has already been noted in the specialist and national press (Hawksworth 1996, Nuttall 1998).

As lichens are long-lived and detectable with a hand lens, the list is probably reasonably comprehensive, although some additional minute crustose species could have been missed, for example in crevices of stonework.

This contribution provides information on changes in local sulphur dioxide levels, the habitat ecology of lichens in Buckingham Palace Garden, and compares the site with others in Greater London.

Changes in sulphur dioxide levels

Sulphur dioxide levels have dropped dramatically in London since the 'killer smog' of December 1952, when levels reached 2,123 µg m^{-3} (0.75 ppm; conversion rate 1 ppm $S0_2$ = 2,830 µg m^{-3} at 15°C). This episode resulted in over 4,000 human deaths more than would have normally been expected, and led to the passing of the Clean Air Act in 1956. Subsequent introductions of clean air regulations, changes from coal to natural gas for heating, and the closure or relocation of industries and power stations have led to a continuing decline since that time.

Mean winter sulphur dioxide levels provide the best fits to lichen patterns as lichens are physiologically more active in the period September to March. In Westminster these values fell from 450 µg m^{-3} in 1962 to 150 µg m^{-3} in 1978 (Rose & Hawksworth 1981). Data from the same Westminster gauge have ceased to be collected, but by 1987 levels in central London were down to 44–48 µg m^{-3} (Hawksworth & McManus 1989). The main reason for this last drop was the closure of Battersea Power Station which ceased emissions in 1983.

In the period January to June 1996, weekly measurements of sulphur dioxide and nitrogen dioxide were obtained from samplers placed in Buckingham Palace Garden. During this period weekly values ranged from undetectable to 75 µg m^{-3} (26.5 ppb), and the mean from January to March was 26 µg m^{-3} (9.3 ppb). Nitrogen dioxide levels obtained from the same samplers gave weekly values in the range 23–53 ppb. The sulphur dioxide data collected during this time, while indicative of a continuing decline, cannot be computed to a winter mean value as no data were collected from September to December.

Particulate matter (smoke) values have not been analysed in the same depth as sulphur dioxide but follow a similar trend in the London area as a whole. Ozone is of particular and increasing concern in the region, but is not known to have harmful affects on lichens although it may adversely affect green plants. No data on ozone levels in the garden are available.

Habitat ecology

Bark and wood

Seventeen species were found on bark or wood. The *Salix* trees by the Lake (tree numbers 1818 and 1825) are the richest in the extent of lichen cover, with the most sulphur dioxide-sensitive species found in the survey, viz. *Evernia prunastri, Parmelia caperata,* and *Ramalina farinacea.* Although one *Salix* was cut down in 1996, and only the stump remains, no species were lost from the Garden as a result. The rough-barked basal areas of *Platanus* are the next most important site for lichens on bark and are better for species associated with nutrient-rich habitats, notably *Phaeophyscia orbicularis, Physcia adscendens, P. tenella* and *Xanthoria parietina. Platanus* (number 1802) was noteworthy in having *Evernia prunastri, Parmelia sulcata, Physcia tenella,* and *Ramalina* together on its base. One *Populus* (number 1836) was also of especial interest as the only site for three species in the Garden, *Caloplaca holocarpa, Lecanora dispersa* and *Rinodina exigua.*

The pollution-tolerant *Lecanora conizaeoides,* found only on one of the bridges in the previous survey, is now widespread but appears to be somewhat unhealthy, as in many areas of lowland Britain where sulphur dioxide levels have fallen dramatically.

Measurements of the diameter or heights of thalli are included in the species list below. Comparison with recorded growth rates (Fisher & Proctor 1978, Rose & Hawksworth 1981) suggest that the first *Parmelia caperata* became established in about 1992, and the first *P. sulcata* in about 1989. These data are consistent with previous findings regarding dates of colonization in the London area (see below). As is usual in areas formerly severely affected by sulphur dioxide pollution, the older vertical trunks of trees remain slow to be colonized by leafy (foliose) lichens. This is generally interpreted as due to the bark having become impregnated with pollutants during the periods of elevated air pollution.

Brick, stone, concrete, and roofing materials

The two bridges to the island on the Lake are made of a granular calcareous stone and have a spectacular lichen cover dominated by greyish and orange species. *Caloplaca citrina, Candelariella aurella, Lecanora flotowiana, L. muralis, Phaeophyscia orbicularis, Verrucaria viridula* and *Xanthoria parietina* predominate, but there are also substantial colonies of *Lecania erysibe* and *Rinodina gennarii*. Also noteworthy on the bridges are *Caloplaca decipiens* (also found on the balustrade on the west side of the Palace), *Phaeophyscia nigricans* and *Xanthoria elegans*. The limestone of the Summerhouse and the wall behind it were the next richest area, and this was the only site where *Catillaria lenticularis* was found in the Garden. Walls within the Garden tend to have similar assemblages of species to those on the bridges, but are relatively species-poor.

The stonework of the Palace itself is disappointing lichenologically as it appears to be deliberately kept 'clean', although one mossy area yielded *Collema crispum*, a cyanobacterial lichen not seen elsewhere in the Garden. Circular patches of *Lecanora muralis* have been allowed to persist in some unscrubbed parts of the main patio. The top of the balustrade on the west side of the Palace supported two small thalli of *Caloplaca decipiens*, and the rough sculptured wall below it supported ten species, including *Lecanora crenulata*, but was otherwise unremarkable. The west side of the Palace and its associated works were richer lichenologically than the north side.

The moveable cover of the Sandpit was noteworthy for the abundance of *Physcia caesia* and the generally scarce *P. dubia*.

Monuments in the Garden are generally kept clean, and the brickwork of the boundary wall is generally free of lichens except for species such as *Lecanora muralis*. A handsome colony of *Trapelia coarctata* on damp brickwork by the Storeyard was of especial note.

Soil

The only ground-dwelling lichen found in the present survey was *Cladonia fimbriata* on Small Island.

Comparison with other sites

Hawksworth & McManus (1989) presented species lists of lichen-forming fungi found on trees in fifty sites in the north-west quadrant of London. They found between two and twenty-two species at each site, and seven to seventeen in the central London parks. In the parks immediately adjacent to the Palace, they recorded seven species in St James's Park, and eleven in Green Park. These sites have not been resurveyed recently, but improvements in the lichens present would have been expected. Although *Parmelia caperata, P. subaurifera* and *Ramalina farinacea* were not then recorded in those two Parks, these and other pollution-sensitive species have all been gaining ground in London in the last 5–10 years. The *P. caperata* is of especial interest as it had not been recorded in London area between 1780 and 1988 (Laundon 1970, Hawksworth & McManus 1989). It now seems remarkable that less than thirty years ago the only site for the now frequent *P. sulcata* within 16 km of central London was one specimen on the concrete coping of a garden wall in Wood Green (Laundon 1970).

The species on trees that have recolonized are ones which would now be expected to be able to survive in central London on the basis of a comparison of the ambient levels of sulphur dioxide they tolerate in the field (Hawksworth & Rose 1970) and current levels of this pollutant (see above). For example, the presence of *Parmelia caperata* and *Phaeophyscia orbicularis* is indicative of mean winter sulphur dioxide levels of about 50 μg m^{-3} or less.

As sulphur dioxide levels have fallen rapidly, some species preferring more acid situations have not been able to colonize. Amongst such 'zone skippers' are species such as *Hypogymnia physodes* or *Platismatia glauca* which were not found in the Garden. Many other species in zone 7 or lower zones of Hawksworth & Rose's scale might be expected but have not yet been found in the site. Amongst these are characteristic 'zone-dawdlers' such as *Graphis, Opegrapha* and *Pertusaria* species (Gilbert 1992).

No systematic survey has been undertaken of species on stonework and similar substrata in the London area since that of Laundon (1970). This makes objective comparisons difficult as major extensions of ranges similar to those documented for species on trees have undoubtedly occurred. The recent colonists *Caloplaca decipiens, Physcia dubia* and *Xanthoria elegans* in the Garden are especially notable in this regard.

Prospects for the future

In a recolonizing situation, there is a certain serendipity in which species occur at what time. Foliose and shrubby lichens, including species of *Evernia, Parmelia* and *Ramalina,* are probably mainly brought into disjunct areas such as the Garden as asexual vegetative reproductive structures (e.g., soredia) and thallus fragments on the feet and in the feathers of birds. When one thallus is established, founder-effects come into play and the species can spread by rain trickles and invertebrates on the same tree and even to adjacent ones. For this reason it is not uncommon to find a single large and several smaller (younger) thalli of the same species close to one another.

Provided that sulphur dioxide levels remain as low as at present in the Garden, species such as *Candelaria concolor, Parmelia perlata, P. revoluta, Usnea subfloridana,* and *Xanthoria polycarpa* can all be expected to arrive in due course. All these species are now expanding widely in north-west London.

As most mature trees in the Garden are numbered, a re-examination of the same trees, and also the two bridges, in 5–10 years would be of interest to see how the recolonization process has continued.

The only other threats to lichens in the Garden are from the 'cleaning' or repairing of stonework. While repairs may be necessary from time to time, 'cleaning' should be discouraged in the interests of wildlife conservation. This is not only an issue for the lichens, but for moths and other invertebrates that need them for food, camouflage, or shelter. Some fungi are also found only on lichens, including several discovered in the Garden, such as *Bispora christiansenii.*

List of Lichen-forming fungi recorded from Buckingham Palace Garden

The nomenclature in this list follows Purvis, Coppins & James (1993) with later modifications. The single species recorded in both the previous and the present surveys is indicated by an asterisk (*), and one erroneous record from the earlier survey is placed in square brackets [. . .]. Numbers in brackets after the names of trees are those on the metal tags nailed to the trees. IMI = reference collection of the CAB International Bioscience UK Centre (Egham).

ASCOMYCOTA

Buellia punctata (Hoffm.) Massal., 1852: on *Salix* (1818) by the Lake; rare.

Caloplaca citrina (Hoffm.) Th. Fr., 1860: on mortar of wall of Silver Border, Sundial, wall behind and wall of Summerhouse, balustrade on west side of Palace, and Bridges Nos 1 and 2; frequent.

C. decipiens (Arnold) Blomb. & Forss., 1880: on Bridge No. 1 (a single specimen), and on balustrade on west side of the Palace (3 specimens, largest 1.1 cm diam.); rare.

C. holocarpa (Hoffm.) Wade, 1965: on *Populus* (1836); one specimen 0.75 cm diam; very rare.

Candelariella aurella (Hoffm.) Zahlbr., 1928: on wall of Silver Border, wall behind and of Summerhouse, balustrade on west side of House, and Bridges Nos 1 and 2; frequent.

C. vitellina (Hoffm.) Müll. Arg., 1894: on Bridge No. 2, also on rough *Populus* bark (1836); occasional.

Catillaria lenticularis (Ach.) Th. Fr., 1874: on limestone wall behind Summerhouse; scarce.

Cladonia fimbriata (L.) Fr., 1831: on ground on Small Island, and *Salix* stump by Lake (G6); rare.

[*C. foliacea* (Huds.) Willd., 1787: 'on peat blocks' (McClintock 1964). This is a species of well-drained calcareous or other basic soils, especially near the coast, and this record was evidently based on basal squamules of another *Cladonia* species. No specimen appears to have been retained, but this interpretation has been confirmed verbally with Dr F. Rose (pers. comm.).]

Collema crispum (Huds.) Weber ex Wigg., 1780: amongst mosses on damp shaded wall on north side of Palace; one small patch.

Evernia prunastri (L.) Ach., 1810: on *Fraxinus* base (1813), *Platanus* base (1802), and *Salix* (1825), a single specimen on each, the largest 1.5 cm tall.

Lecania erysibe (Ach.) Mudd, 1861: on Bridges Nos 1 and 2, on rockery stone in Mud Hole Walk and ballustrade on west side of House; occasional.

Lecanora albescens (Hoffm.) Branth & Rostrup, 1869: on wall of Summerhouse, and ballustrade on west side of House; occasional.

* *L. conizaeoides* Nyl. ex Crombie, 1885: on trees; very common. Recorded in the previous survey not on trees but 'on sandstone bridge' (McClintock 1964); found only on trees in the present survey.

L. crenulata Hook., 1833: on limestone wall of Summerhouse, and rough stonework below balustrade on west side of the Palace; rare.

L. dispersa (L.) Sommerf., 1826: on *Populus* bark (1836); scarce.

L. flotowiana Spreng., 1820: on wall of Silver Border, wall behind Summerhouse, balustrade on west side of Palace, Sundial, and Bridge No. 2; locally very common. The species to which most UK records of *L. dispersa* on rocks and walls refer, according to the concepts adopted in the revision of Fröberg (1997).

L. muralis (Schreber) Rabenh., 1845: on wall of Silver Border, flagstones of patio on west side of the Palace, wall behind Summerhouse, on Bridge No. 2, Sandpit cover, and boundary wall (Sects 22–23); locally abundant.

Lecidella stigmatea (Ach.) Hertel & Leuckert, 1869: on Bridge No. 2; scarce.

Lepraria incana (L.) Ach., 1803: on shaded dry bark of trees (e.g., 1825, 1837, 4794), *Salix* stump by Lake (G6), also boundary wall (Sect. 16); frequent.

Parmelia caperata (L.) Ach., 1803: on *Salix* (1818) by the lake, very rare, one thallus 0.6 cm diam; on *Salix* (1825) by the Lake, one thallus 2.2 cm diam.

P. subaurifera Nyl., 1873: on *Salix* (1793, 1818), occasional, thalli to 4.2 cm diam.

P. sulcata Taylor, 1836: on *Platanus* (e.g., 1802, 4964), *Salix* (e.g., 1793, 1818), and *Tilia* (4861); occasional, thalli to 2.7 cm diam.

Phaeophyscia nigricans (Flörke) Moberg, 1977: on Bridge No. 1; rare.

P. orbicularis (Necker) Moberg, 1977: on trees (e.g., *Platanus* 1719, 4964; *populus* 1836), Sandpit cover, balustrade on west side of Palace, and Bridges 1 and 2; locally abundant.

Physcia adscendens (Fr.) H. Olivier, 1882: on *Platanus* (4964), *Populus* (1836, 4859), and unidentified tree (1825); occasional.

P. caesia (Hoffm.) Fürnrohr, 1839: on Bridge No. 2, Sandpit cover, and *Platanus* base (4964); locally abundant.

P. dubia (Hoffm.) Lettau, 1912: on Sandpit cover; locally abundant, IMI 373915.

P. tenella (Scop.) DC., 1805: on trees (e.g., *Platanus* 1719, 1802, 1867, 4964), *Salix* 1818 and *Populus* 1836); locally abundant.

Porina chlorotica (Ach.) Müll. Arg., 1884: on ledge of patio wall, north side of the Palace; no ascospores obtained; rare.

Ramalina farinacea (L.) Ach., 1810: on *Platanus* base (1802); a single thallus; very rare.

Rinodina exigua Gray, 1821: on *Populus* (1836); rare.

R. gennarii Bagl., 1861: on wall below balustrade on west side of Palace, wall of Silver Border, Sundial, and on Bridges Nos 1 and 2; occasional.

Scoliciosporum chlorococcum (Graewe ex Stenhammar) Vězda, 1978: on *Platanus* base (1792), and rough bark of *Populus* (1836); scarce.

Trapelia coarctata (Sm.) M. Choisy, 1932: on damp horizontal brickwork, Storeyard; abundant on one wall.

Verrucaria muralis Ach., 1803: on pulmonite on The Mound; rare.

V. nigrescens Pers., 1795: on limestone wall of Summerhouse, and balustrade on west side of Palace; scarce.

V. viridula (Schrader) Ach., 1803: on wall of Silver Border, Summerhouse, balustrade on west side of Palace, and Bridges Nos 1 and 2; occasional.

Xanthoria elegans (Link) Th. Fr., 1860: on Bridge No. 2, two specimens, 1.2 and 1.4 cm diam.

X. parietina (L.) Th. Fr., 1860: on Bridges Nos 1 and 2, wall behind Summerhouse, and on bark of *Platanus* (1868, 4964), *Populus* (1836) and unidentified tree (4794); locally abundant, specimens to 3 cm diam.

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Non-lichenised fungi in Buckingham Palace Garden

It was originally planned to include a paper on the non-lichenised fungi in this first part of the report on the surveys at Buckingham Palace Garden. Around 700 species have been recorded, including two published as new to science. Many mycological specialists have contributed towards their identifications. Unfortunately, as a consequence of his many other commitments, Alick Henrici has been unable to complete the monumental task of compiling this particular section in advance of my strict deadlines. The reader is invited to consider that preparing the papers for this *Supplement* is an entirely voluntary labour on the part of all the authors; when dealing with over seven hundred species, all of which require to be critically examined under a microscope, preparation of an accurate list and discussion thereon is especially time-consuming. The paper on non-lichenised fungi has, therefore, been held back and will appear in part 2, to be published in December 2001.

Bryophytes in Buckingham Palace Garden 1995 - 1998

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Summary

Sixty species of bryophyte were found in Buckingham Palace Garden during the period 1995 to 1998; this compares with thirty-one species in the 1960 to 1963 survey. Additions to the British flora since that time account for part of the increase. Reduction in air pollution is another significant factor. Attention is drawn to species of particular interest, and all species are listed, including four recorded in the earlier survey but not refound during the present work.

Introduction

There would be more mosses and liverworts in the garden 'if there were less pollution in the atmosphere, a less dry climate and less active gardening'. Such was the conclusion reached by the previous survey (McClintock 1964). Since then, the climate, despite wet or dry seasons, has not radically altered, and gardening is just as active. However, air pollution has been dramatically reduced, thanks to the Clean Air Acts of 1956 and 1968. Sulphur dioxide, a product of coal and oil consumption, was extremely harmful to London's bryophytes. Certain species became 'virtually extinct in central London and the inner suburbs during the worst of the pollution' (Adams & Preston 1990). With cleaner air, some are reappearing, a trend which seems to be reflected in Buckingham Palace Garden. Fifty-six moss and four liverwort species were found here during the present survey, from 1995 to 1998, compared with twenty-six mosses and five liverworts during the earlier work.

Not all of this increase is attributable to reduced pollution. Since the previous survey, there have been many additions to the British bryophyte flora. New species have been recognized, others have been subdivided, and aliens have arrived. *Hennediella macrophylla*, for example, a native of New Zealand, was first noted in London in 1968 and is now widespread in the central parks.

Three mosses recorded during the previous survey were not refound: these were *Weissia* sp., *Physcomitrium pyriforme* and *Eurhynchium hians* (*E. swartzii*), probably due to chance. The liverwort *Pellia epiphylla* was also not refound, possibly because its habitat has been lost. In the earlier survey, the best bryophyte site, of which there is now no trace, was 'the marshy ground by the lake where damp little-disturbed grassland supports at least 12 species'. In any case, with bryophytes some random gains and losses are inevitable, especially in such an intensively managed environment. For example two bog mosses, *Polytrichum longisetum* and *P. commune*, were introduced with peat blocks from Scotland in 1995, and the only colony of *Dicranoweisia cirrata*, which grew on an old weeping willow, was lost in 1996 when the tree had to be felled. However, most species recorded here are more or less permanently established in appropriate habitats.

These habitats include soft verges of the lake. In places, tangled tree roots reach the water and mosses grow among them, including the rarest found in the garden, a variety of *Bryum pseudotriquetrum*. Normally associated with marshes, fens and dripping rocks, it is infrequent in south-east England and very scarce in Middlesex, the only other record during the past half-century being from Ruislip Lido (Wiltshire & Ellis 1995).

The West Terrace, with its balustrades and other architectural features of Portland stone, provides nooks and crannies which harbour a mixture of very small mosses. Although almost invisible except in early spring, these are locally plentiful and include *Fissidens* species, *Tortula truncata* (*Pottia truncata*), *Didymodon rigidulus* (*Barbula rigidula*), *Bryum rubens* and pollution-sensitive *Syntrichia intermedia* (*Tortula intermedia*).

Several mosses which in nature grow on stone, such as *Syntrichia ruralis* (*Tortula ruralis*), were found on the picturesque boulders and rocky outcrops which adorn The Mound, despite the fact that these are artificial. Concocted from rubble and coated with realistically-moulded cement, they were made by the Pulham company and installed in 1904 (Festing 1985).

On the lawns, the expected mosses are present. In damp places they include *Calliergonella cuspidata* (*Calliergon cuspidata*) and *Rhytidiadelphus squarrosus*, which are absent from the drier neighbouring London parks. On moist ground under trees, *Atrichum undulatum* and *Plagiomnium undulatum* are well established. Except occasionally at their bases, the trees themselves are almost devoid of mosses. Nearly 20 species of *Barbula*, *Didymodon*, *Tortula*, *Pohlia*, *Bryum* and other small mosses are widespread through the garden, often mixed together.

The feet of passing tourists, who visit the Palace each August and September, must be responsible for the presence of *Hennediella macrophylla*. On leaving the Palace, they call at the souvenir shop, a temporary building by the eastern end of The Mound, before making their way out by the Back Path to Grosvenor Place. On the heavily trampled ground by the shop this tiny alien moss is now well established.

The liverworts *Lunularia cruciata* and *Marchantia polymorpha* are locally plentiful on dank clay. *Lophocolea bidentata* is thinly scattered among grasses by the lake, and fragments of *L. heterophylla* were found on damp ground in a shrubbery. *Pellia epiphylla*, present during the earlier survey, was not re-found from 1995 to 1998.

In all, Buckingham Palace Garden contains a good range of bryophytes, many more than were found during recent years in Hyde Park and Kensington Gardens combined (Wiltshire 1994). Seclusion, shade, architectural and landscaped features, together with a generous watering routine, provide an unexpectedly favourable environment.

List of bryophytes recorded from Buckingham Palace Garden

Nomenclature and arrangement follows Blockeel and Long (1998). An asterisk (*) indicates species recorded during 1960-63 survey. 'V' indicates that voucher specimens from the 1995 to 1998 survey are deposited inthe Cryptogamic Herbarium of The Natural History Museum.

MOSSES

Polytrichaceae

Polytrichum longisetum. A few plants (some fruiting) near Waterfall 1998, on peat blocks from Auchencorth Moss near Edinburgh, introduced 1995. Rarely seen in Middlesex. V.

P. commune. A few plants on above peat blocks 1998. A moss of bog and damp heath habitats, now scarce in the London area. V.

P. juniperinum. A few plants on old peat in shrubbery behind Herbaceous Border 1996. V.

* *Atrichum undulatum*. Well established under hornbeam between Waterfall and Mudhole; also on lawn near Tea-house and on Mound. V.

Dicranaceae

* *Ceratodon purpureus*. Widespread.

* *Dicranella heteromalla*. A few plants in shrubbery behind Herbaceous Border 1995. V.

Dicranoweisia cirrata. On leaning willow (felled 1996) opposite Flamingo site. V.

* *Campylopus pyriformis*. In flower-pot in greenhouse 1996 (det. L. T. Ellis). V.

C. flexuosus (*C. paradoxus*). A few plants by Island shore 1997. V.

C. introflexus. First recorded in Britain in 1941. In flower-pot in Yard 1995 and sparsely by Island shore 1996, 1998. V.

Fissidentaceae

Fissidens bryoides. Locally abundant on West Terrace; also on Mound and along shaded path edges. V.

F. taxifolius. Sparsely on West Terrace and on Mound. V.

Pottiaceae

* *Weissia* cf *controversa.* Not refound.

Pseudocrossidium hornschuchianum (*Barbula hornschuchiana*). Occasional among other mosses. V.

Bryerythrophyllum recurvirostrum. A few plants on Island 1998.

* *Barbula convoluta.* In beds and by paths with other small mosses. V.

B. unguiculata. Frequent, especially on shaded stretches of path. V.

Didymodon rigidulus (*Barbula rigidula*). Small colonies on Portland stone of West Terrace balustrade 1998 (det. L. T. Ellis). V.

D. insulanus (*B. cylindrica*). Occasional among other mosses. V.

D. luridus (*B. trifaria*). A few plants by path behind Herbaceous Border 1996. V.

* *D. tophaceus* (*B. tophacea*). Occasional by Lake. V.

* *Tortula muralis.* Abundant on boulders. V.

T. modica (*Pottia intermedia*). A few plants in bed near Clock-tree Corner 1996.

T. truncata (*P. truncata*). On West Terrace, in beds, by paths and on Island. V.

T. acaulon (*Phascum cuspidatum*). Occasional in beds and by paths. V.

Hennediella macrophylla. First recognized in Britain in 1965. Fruiting plants on bare ground by souvenir shop site 1998. V.

Syntrichia ruralis (*Tortula ruralis*). A few plants on boulder by Back Path 1995. V.

S. intermedia (*T. intermedia*). Occasional at base of West Terrace parapet among *Bryum rubens*, etc. V.

Grimmiaceae

Grimmia pulvinata. Occasional on boulders. V.

Funariaceae

* *Funaria hygrometrica.* Frequent.

* *Physcomitrium pyriforme.* Not refound.

Bryaceae

* *Leptobryum pyriforme.* A few plants near 'Cranes' 1995 (det. L. T. Ellis). V.

* *Pohlia nutans.* Occasional on Island and by Lake. V.

* *P. annotina.* Among other mosses on West Terrace; a few plants on top of Mound 1998. V.

P. lescuriana. Not recognized in Britain until 1964. With *P. annotina* on West Terrace and on the Mound, 1998. V.

* *P. melanodon* (*P. carnea*, *P. delicatula*). Occasional by Lake. V.

* *Bryum capillare.* Frequent on boulders, paths and by Lake. V.

B. pseudotriquetrum var. *binum.* Small colonies by west side of Lake between Bridge No. 1 and Table, at water's edge among compacted tree roots (det. L. T. Ellis). Rare in Middlesex. V.

* *B. caespiticium.* Frequent. V.

* *B. argenteum.* Occasional, especially on paths.

B. gemmiferum. Not recognized in Britain until about 1965 - formerly in **B. bicolor* complex. Frequent among other small mosses. V.

B. ruderale. First recognized in 1964 - previously in **B. erythrocarpum* complex. By path at rear of Herbaceous Border 1996 (det. L. T. Ellis). V.

B. rubens. Previously in **B. erythrocarpum* complex. Locally abundant on West Terrace and occasional throughout the garden. V.

Mniaceae

* *Mnium hornum.* At various sites on west side of Lake and on Mound. V.

Plagiomnium undulatum. Established in shrubbery by Clock-tree Corner. V.

Orthotrichaceae

Orthotrichum diaphanum. On base of sycamore by Herbaceous Border; occasional on other tree-bark and on boulders. V.

Amblystegiaceae

Amblystegium serpens. Frequent. V.

* *Leptodictyum riparium*. Occasional by Lake. V.

Calliergonella cuspidata (*Calliergon cuspidatum*). On moist ground between Mound and Lake; on shaded lawn near Tea-house. V.

Brachytheciaceae

Homalothecium sericeum. A few plants at base of horse-chestnut tree on Island 1995. V.

Brachythecium albicans. Plentiful on Island, occasional elsewhere. V.

* *B. rutabulum*. Widespread.

* *B. velutinum*. Rare at tree bases. V.

Rhynchostegium confertum. Frequent. V.

* *Eurhynchium praelongum*. Widespread. V.

* *E. hians* (*E. swartzii*). Not refound.

Hypnaceae

* *Hypnum cupressiforme*. Occasional. V.

H. resupinatum On bark of plane tree by Grosvenor Place Walk 1996. V.

Rhytidiadelphus squarrosus. On moist ground between Mound and Lake; on North Terrace lawn; on lawn near Tea-house. V.

LIVERWORTS

Geocalycaceae

* *Lophocolea bidentata* (including *L. cuspidata*). Occasional by Lake and in other moist locations. V.

* *L. heterophylla*. On damp ground in shrubbery 1995.

Pelliaceae

* *Pellia epiphylla*. Not refound.

Lunulariaceae

* *Lunularia cruciata*. Occasional in damp shaded sites; in flower-pots in Yard.

Marchantiaceae

* *Marchantia polymorpha* ssp. *ruderalis*. Occasional on damp ground by Lake; abundant on wet paving in Yard; in flower-pots. V.

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Wild and naturalized vascular plants in Buckingham Palace Garden 1995 - 1998

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Summary

This paper lists the 322 taxa of wild and naturalized plants recorded in Buckingham Palace Garden from 1995 to 1998 and three added during 1999. About a hundred of these were new to the Garden. Three were new to Middlesex: *Selaginella kraussiana* Krauss's clubmoss, *Trachystemon orientalis* Abraham-Isaac-Jacob, and *Veronica hederifolia* ssp. *hederifolia* ivy-leaved speedwell. The nationally scarce hawkweed *Hieracium lepidulum* var. *haematophyllum* was refound, and London rarities included *Ophioglossum vulgatum* adder's-tongue, *Fumaria vaillantii* few-flowered fumitory and *Dactylorhiza fuchsii* common spotted orchid. The history of previous records is outlined. Of these, 218 taxa were refound and about a hundred not refound. They have been incorporated in this list, making a total of 431 taxa seen in the Garden since 1950. Attention is drawn to plants of particular interest. Recording was carried out, on average, weekly by the authors during the period 1995 to 1997, and occasionally during 1998.

Previous records

Galinsoga parviflora gallant-soldier, 'In the grounds of Buckingham Palace, Mme Dussan', was an early record published by G.C. Druce (1917), but it was not until 1950 that proper note was taken of the Garden flora. D.M. Eastwood, who was recording all the wild plants she could find in central London, had an opportunity to extend her list during a Palace garden party on 16 May 1950. In her book *Mirror of flowers* (1953) she refers to seven species, including *Hydrocotyle vulgaris* marsh pennywort. This was added to the hand-list of London plants then in course of publication (Kent & Lousley 1953), as was *Oenanthe crocata* hemlock water dropwort, which was among records personally communicated by her to D.H. Kent.

On 5 June 1956, J.C. Codrington, D.H. Kent, J.E. Lousley and D. McClintock visited the Garden to record its wild and naturalized flora. They found 'a thirty-nine acre haven walled off from the rest of the metropolis for over a century, well provided with water, bushes and other vegetation, free from public disturbance, and largely unexamined' (McClintock 1964). On 4 September they came again. Lousley (1957), reported that about 175 species had been listed, of which he published fourteen. McClintock returned on 9 April 1957 to make further records, and in 1960 Kent published 63 of the species so far found.

Meantime a team of scientists had been assembled to study the Garden's natural history in general, and the 1960-1963 survey took place. Particulars of the wild and naturalized plants, including the 1956 and 1957 records, amounting in all to nearly 270 taxa, were included in the comprehensive report (McClintock 1964).

From 1964 to 1994, McClintock continued to make occasional visits and to note additions to the Garden flora, including *Ophioglossum vulgatum* adder's-tongue, which featured in radio and television programmes, and *Euphorbia hirta* asthma-plant, new to Britain. In all, he added some fifty further plants, of which fourteen were published from time to time. These, and his unpublished records, are incorporated in this list. Many of the records referred to above were summarized by D.H. Kent in his *Historical Flora of Middlesex* (1975). A Supplement to this work is due for publication during 1999, and will include some records from this survey.

1995-1998 survey

A new survey of the wild and naturalized flora began in March 1995. Visits by the authors, together or separately, took place on a more or less weekly basis throughout the first three seasons, and occasionally in 1998. Three hundred and twenty-five taxa were recorded, of which about a hundred were new to the Garden. Of these, three were also new to Middlesex: *Selaginella kraussiana* Krauss's clubmoss, *Trachystemon orientalis* Abraham-Isaac-Jacob, and *Veronica hederifolia* ssp. *hederifolia* ivy-leaved speedwell (Kent 1999).

Specialists were consulted regarding critical and other species, and many voucher specimens have been deposited in the Natural History Museum and elsewhere. All taxa found during this period are listed here, together with previous records, making a total of 431. Over one hundred previously recorded taxa were not refound. These included twenty-three of bird-seed origin, twelve waterside plants, seven trees and shrubs, six grasses and five dandelion species. Others had been introduced with plants and materials, or associated with landscaping works. Thus, only after the Cascade was built in 1961 were seen bulbous buttercup, two bittercresses, thale-cress, three St John's-worts, annual pearlwort, fairy flax, lanceolate willow-herb, pignut and two of the three speedwells (McClintock 1964). Of such arrivals, not all would survive even to a second season. Random weeds comprise the balance of 'missing' species.

Local habitats

The area of the Garden is about 16 hectares (39 acres) – its principal features are shown on the map on pages 2–3. These include the West Terrace of the Palace itself. On the inner side are a series of grassy banks which slope towards the basement. *Viola riviniana* common dog violet and *Galium verum* lady's bedstraw are among plants which have grown on these from at least the 1960s. A gravelled walk along the terrace overlooks the main lawn, where thousands of guests assemble during garden parties. This extends towards Hyde Park Corner, with The Lake to the left, and flower beds and shrubberies to the right. The boundary walls along Grosvenor Place and Constitution Hill are lined with trees and shrubs, beneath which wild plants are little disturbed.

The lake, covering 1.5 hectares (about 4 acres), has soft margins and a wealth of vegetation to the water's edge. It contains an island, connected by two bridges. For long, part of this was home to the flamingoes, but since these perished in 1996 the site has been re-landscaped. A separate islet is no longer accessible. Water supplies are recycled via the waterfall at the north-west tip of The Lake. Other lakeside features include a flight of stone steps and a pair of bronze Indian cranes.

The Mound, a high sinuous ridge formed when the Garden was laid out, screens service areas from the Palace. It is grassy, and landscaped with trees, shrubs and artificial boulders. Behind this is the Yard, site of the Garden's administrative area, through which plants and materials enter the Garden.

Wild species

Some species may have been present here since before the Garden was created. The best-known is *Chamaemelum nobile* chamomile, which was recorded by Merrett (1666) as being 'this side of Hyde Park', and just to the south of the present Garden (McClintock 1977). It forms portions of lawn turf. Riparian species also may have been part of the original vegetation. In the eighteenth century there were two small lakes nearby, on ground which had always been wet – about 1825 the present lake was formed. Plants that might have survived by seed or otherwise from earlier times include *Lycopus europaeus* gipsywort, *Scrophularia auriculata* water figwort, *Hydrocotyle vulgaris* marsh pennywort and *Oenanthe crocata* hemlock water dropwort (common locally in the seventeenth century).

Hydrocotyle vulgaris marsh pennywort is now a London rarity, decreasing in Middlesex (Kent 1999). It persists where The Lake margin is soft and tree-shaded – perhaps the only such habitat in the city. Other locally rare or uncommon plants include *Ophioglossum vulgatum* adder's-tongue. First noted here in 1979 by D. Mitchell, the then head gardener, it may have been present for much longer. A colony of *Geranium rotundifolium* round-leaved crane's-bill, flourishing in a shrubbery, was engulfed by earth-moving in 1997 but appears to be recovering. Also locally scarce are *Montia fontana* ssp. *chondrosperma* blinks, *Trifolium arvense* hare's-foot clover, and *Aira caryophyllea* ssp. *multiculmis* silver hair-grass.

Of particular interest is *Hieracium lepidulum* var. *haematophyllum*, a nationally rare hawkweed. A specimen collected in the Garden in 1956 was determined by P. Sell and C. West (Lousley 1958). Up to 1961, this also grew outside the Garden wall, on the projection towards Hyde Park, but was lost when the roundabout there was enlarged. In 1995, a good colony was found in the Garden, by the north edge of The Lake.

A plant of *Dactylorhiza fuchsii* common spotted orchid flowered on the east side of The Lake in 1995. It reappeared during following seasons and was still present in 1999. In 1998, across The Lake, several others bloomed among newly planted-out iris clumps. Their source was an orchid which had been rescued from an Essex building site about 1993 and deposited in the Palace Garden yard. Here it seeded into the neighbouring iris pots. In 1999, thirty spikes flowered.

The locally rare *Orobanche minor* var. *minor* common broomrape appeared in 1998, apparently on *Trifolium dubium* lesser trefoil. Other unlikely Inner London plants seen were *Cardamine bulbifera* coralroot and *Veronica catenata* pink water-speedwell.

Naturalized and casual species

Around The Lake, naturalized species such as *Lysimachia vulgaris* and *Lythrum salicaria*, yellow and purple loosestrifes, mingle with a diversity of reeds and sedges. In 1956 McClintock noted that an unusual sea club-rush here, *Bolboschoenus maritimus*, was 'very pale green and tall'. Recently a specialist, Dr Jane Browning, looked at the fruits of a specimen in The Natural History Museum and found that it had the characteristics of a Japanese species, *B. yagara* (Ohwi) R.E. Kozhevnikov as well as of *B. maritimus*, and was possibly of hybrid origin. The plant has since been lost from The Lake.

Elsewhere in the Garden, other species, planted long ago for decorative effect, grow in abundance. Prominent among these is a *Heracleum* giant hogweed, still defying precise identification. It differs from the usual *H. mantegazzianum* in being perennial, with shorter stems and an extra pair of leaflets (McClintock 1968). Another is *Chaerophyllum aureum* golden chervil from central Europe. It is as frequent here as *Anthriscus sylvestris* cow parsley, but flowers somewhat later and has aromatic foliage, which persists green for much of the year. It has been naturalized in Scotland since the early years of this century, but is a rare casual elsewhere in Britain.

Several varieties of once-prized knotweeds have long formed part of the lakeside vegetation. They have been closely studied by experts (details are in the archives of The Natural History Museum). Basically there are two species, *Fallopia japonica* Japanese knotweed, *F. sachalinensis* giant knotweed, their hybrid *F. x bohemica*, and the var. *compacta* of *F. japonica*. Attempts are now being made to clear them all from the Garden.

Many naturalized plants here are of accidental origin. Some derive from garden escapes and abandoned beds. In the past, peat blocks were an occasional source, bringing *Dryopteris dilatata* broad buckler-fern, *Erica* spp. heathers and *Molinia caerulea* purple moor-grass. Casuals sometimes arrive inadvertently with nursery stock, or introduced materials. When the flamingo site was renovated, soil was brought in to shore up the banks and *Fumaria vaillantii* few-flowered fumitory, a plant of chalk stubble and otherwise unknown in London, appeared. In 1997 another load brought *Chenopodium bonus-henricus* good-king-Henry and *Digitaria ischaemum* smooth finger-grass to the Yard. Usually such arrivals do not last long. However an alien which is surely here to stay is *Conyza sumatrensis* Guernsey fleabane, first recorded in London in 1983 (Burton 1995) and now rampant throughout the city.

Up to the early 1980s, birds were fed from a balcony on the north front of the Palace. On the gravel below fell what they did not eat. The resulting seedlings when grown on produced a surprising diversity of species. Among them was the pan-tropical *Euphorbia hirta* asthma-plant, not previously recorded in Britain (Burton 1979; Clement & Foster 1994). Seven bird-seed species had been recorded during the 1960-1963 survey, and with twenty similar casuals subsequently added by McClintock they form a significant proportion of past records. There is no record of bird-seed being used during this survey.

Conclusion

A remarkable range of wild and naturalized plants has been recorded in the Garden. About half comprises naturally-occurring species, and a quarter has originated through planting or other gardening operations. The balance consists mainly of transient weeds, common throughout London.

In the thirty-five years between the previous and current surveys about a hundred taxa were lost from the Garden's flora and another hundred gained. This turnover appears to be a consequence of intensive gardening and of chance, rather than a reflection of any particular trend, pollution level or climate variation.

This sheltered and well-watered site provides ideal habitats for plants which might not otherwise survive in central London. These include rarities already referred to, inconspicuous plants such as *Viola riviniana* dog violet and *Galium saxatile* heath bedstraw, and some of the waterside vegetation, as well as random exotics both native and introduced. The surveys demonstrate that a major contribution to the enrichment of London's flora is made by the wild and naturalized plants of Buckingham Palace Garden.

List of wild and naturalized vascular plants recorded from Buckingham Palace Garden

The nomenclature in this list and the order of the species follows Stace (1997). An asterisk (*), indicates records made from 1956 to 1964 (McClintock 1964). (DMcC) indicates unpublished records made by David McClintock between the two surveys. 'V' indicates that a voucher specimen has been retained; most of these are in the herbarium at The Natural History Museum.

Selaginaceae

Selaginella kraussiana Krauss's clubmoss. On shaded lawn near Tea-house. First record for Middlesex (Burton 1996: 142). V.

Equisetaceae

* *Equisetum arvense* field horsetail. Established near Bridge No. 1 and occasional near Steps. V.

Ophioglossaceae

Ophioglossum vulgatum adder's-tongue. A small colony opposite Flamingo site, first noted in 1979 (Burton 1980: 82). V.

Osmundaceae

* *Osmunda regalis* royal fern. A few planted clumps by Lake, persisting since 1959.

Dennstaedtiaceae

* *Pteridium aquilinum* ssp. *aquilinum* bracken. Near Firehole and occasional elsewhere.

Aspleniaceae

* *Phyllitis scolopendrium* hart's-tongue. Bifurcated fronds 1965 (DMcC). On Yard wall 1995; in crevice in west front of Palace 1997.

* *Asplenium ruta-muraria* wall rue.

Dryopteridaceae

* *Dryopteris filix-mas* male fern (Kent 1960: 43). Occasional by south-west wall.

* *D. dilatata* broad buckler-fern. Originally on peat blocks and still occasional.

Woodsiaceae

Matteucia struthiopteris ostrich fern. One plant at south end of Lake (det. A. Paul). Also planted in flower-bed.

Taxaceae

* *Taxus baccata* yew. Occasional seedlings.

Nymphaceae

* *Nymphaea alba* white water-lily (Eastwood 1953: 168). Still present between Island and Waterfall.

Ranunculaceae

Caltha palustris marsh-marigold. Probably planted (Lousley 1957: 15). 1965 (DMcC). Near Waterfall.

* *Ranunculus acris* meadow buttercup. Occasional.

* *R. repens* creeping buttercup. Occasional. V.

* *R. bulbosus* bulbous buttercup. Occasional.

R. sceleratus celery-leaved buttercup. 1969 (DMcC). In disturbed ground near Mudhole 1995; by Flamingo site 1997. V.

R. ficaria lesser celandine. Occasional.

R. hederaceus ivy-leaved crowfoot. Single plant in wallflower bed near Yard, on mulch from Yorkshire 1996 and 1997. V.

* *Aquilegia vulgaris* columbine. Single plant on Mound 1995.

Berberidaceae

Mahonia aquilifolium Oregon-grape. Single seedling 1995.

Papaveraceae

Papaver somniferum opium poppy. On sand in Yard 1998.

P. rhoeas common poppy. Two plants on disturbed ground by Waterfall 1995.

P. dubium ssp. *lecoqii* long-headed poppy. In new bed by Flamingo site 1997.

Chelidonium majus greater celandine. 1993 (DMcC). Established in shrubbery by south-west wall.

Fumariaceae

Pseudofumaria lutea yellow corydalis. In bed behind The Border 1995. V.

* *Fumaria officinalis* common fumitory. In bed near Silver Border 1996; on sand in Yard 1997. V.

F. vaillantii few-flowered fumitory. In new bed near Flamingo site 1997 (Burton 1998: 233). V.

Platanaceae

* *Platanus x hispanica* London plane. Seedlings often present.

Ulmaceae

Ulmus procera English elm (Kent 1960: 52).

Urticaceae

* *Urtica dioica* common nettle. Occasional, including in hanging garden.

* *U. urens* small nettle. Occasional.

Parietaria judaica pellitory-of-the-wall. Single plant in Yard 1996.

* *Soleirolia soleirolii* mind-your-own-business. Abundant by Clock-tree Corner. V.

Fagaceae

Fagus sylvatica beech. Single seedling 1997.

* *Castanea sativa* sweet chestnut. Seedlings rare.

* *Quercus cerris* Turkey oak.

Q. ilex evergreen oak. Occasional seedlings.

Q. robur pedunculate oak. Single seedling 1996.

Betulaceae

Betula pubescens downy birch. Seedling in shrubbery by north wall 1995.

* *Alnus glutinosa* alder.

Carpinus betulus hornbeam. Seedlings near Mudhole 1997.

Chenopodiaceae

Chenopodium bonus-henricus good-king-Henry. On introduced soil in Yard 1997.

* *C. rubrum* red goosefoot. Occasional, notably by Catenary in Rose Garden.

* *C. polyspermum* many-seeded goosefoot. Occasional, especially by Catenary in Rose Garden. V.

* *C. ficifolium* fig-leaved goosefoot (Kent 1960: 46). Now scarce.

* *C. album* fat hen. Now scarce.

* *Atriplex prostrata* spear-leaved orache. Now scarce.

* *A. patula* common orache (Kent 1960: 46). Single plant by Mudhole, 1995.

Spinacea oleracea spinach. Single plant by Mudhole 1995.

Amaranthaceae

Amaranthus retroflexus common amaranth. From bird-seed 1970 (DMcC). Plant on Island 1997. V.

A. standleyanus indehiscent pigweed. From bird-seed 1980 (DMcC).

Portulacaceae

* *Claytonia perfoliata* spring beauty (Kent 1960: 46). In daffodil patch 1998.

C. sibirica pink purslane. In recently-planted shrub bed. V.

Montia fontana ssp. *chondrosperma* blinks. Established on lawn north of Mound (det. S. M. Walters). V.

Caryophyllaceae

Moehringia trinervia three-nerved sandwort. By Lake near Flamingo site. V.

* *Stellaria media* common chickweed. Frequent.

S. pallida lesser chickweed. Single plant in container on North Terrace 1995.

S. neglecta greater chickweed. One large plant by Catenary 1978 (Burton 1979: 67). V.

* *S. graminea* lesser stitchwort. Among grasses by Lake, on Island and by sundial.

* *Cerastium fontanum* ssp. *vulgare* common mouse-ear. Frequent.

C. glomeratum sticky mouse-ear. Occasional in turf. V.

Myoston aquaticum water chickweed. Weed in Yard garden 1985 (Burton 1986: 198). Bed weed 1985-1988 (DMcC). Near Flamingo site 1997.

* *Sagina procumbens* procumbent pearlwort. Occasional.

* *S. apetala* ssp. *apetala* annual pearlwort. In error as ssp. *erecta* (Kent 1975: 213).

Scleranthus annuus annual knawel. 2 - 3 plants in flower bed 1967 (Lousley 1968: 9).

* *Spergula arvensis* corn spurrey.

* *Silene latifolia* ssp. *alba* white campion (Kent 1960: 46). In Arboretum 1997.

S. dioica red campion. Two plants near Recycling Centre 1995.

Vaccaria hispanica cowherb. From bird-seed 1981 (DMcC).

Polygonaceae

* *Persicaria amphibia* amphibious bistort (Kent 1960: 52).

* *P. maculosa* redshank. Now scarce.

* *P. lapathifolia* pale persicaria. Two plants on disturbed ground near Waterfall 1995.

P. hydropiper water-pepper. Single plant in Yard 1995.

* *Polygonum arenastrum* equal-leaved knotgrass. In Yard.

* *P. aviculare* knotgrass. North of Yard.

* *Fallopia japonica* Japanese knotweed. Many locations. V, also in herb. Loughborough and herb. Leicester.

* *F. japonica* var. *compacta*. Long established by Lake west of Table. V, also in herb. Loughborough and herb. Leicester.

F. x *bohemica* (*F. japonica* x *F. sachalinensis*). At least three locations (det. L. Child & J. Bailey). V, also in herb. Loughborough and herb. Leicester.

* *F. sachalinensis* giant knotweed. Established by Lake. V, also in herb. Loughborough and herb. Leicester.

* *Fallopia convolvulus* black-bindweed. Occasional.

* *Rumex acetosella* sheep's sorrel. Occasional (Kent 1960: 52). Abundant in the Gut.

* *R. acetosa* common sorrel. A few plants on Island.

* *R. hydrolapathum* water dock. Probably planted (Eastwood 1953: 168, 175; Lousley 1957: 15). By southern margin of Lake.

* *R. crispus* curled dock. Established on Island; a plant in disturbed ground near Waterfall 1995.

* *R. conglomeratus* clustered dock. Occasional.

* *R. sanguineus* var. *viridis* wood dock (Kent 1960: 52). On Island.

* *R. obtusifolius* broad-leaved dock. Occasional.

Clusiaceae

* *Hypericum perforatum* perforate St John's-wort. A large plant in Silver Border 1996. V.

* *H. tetrapterum* square-stalked St John's-wort.

* *H. humifusum* trailing St John's-wort.

Malvaceae

Malva sylvestris common mallow. Single plant 1997. V.

M. neglecta dwarf mallow. 1993 (DMcC).

Violaceae

* *Viola riviniana* var. *minor* common dog violet. Established on West Terrace and by Lake opposite Flamingo site; single plant by Recycling Centre 1995 (conf. S.M. Walters). V.

* *V. arvensis* field pansy. Occasional weed.

Salicaceae

* *Salix caprea* goat willow.

* *S. cinerea* ssp. *oleifolia* grey willow.

Brassicaceae

Sisymbrium orientale eastern rocket. Occasional 1967-1968 (Lousley 1968: 9). Single plant in Yard 1995.

* *S. officinale* hedge mustard. Occasional.

Alliaria petiolata garlic mustard. Single plant by south-west wall 1995.

* *Arabidopsis thaliana* thale cress. Scarce.

Erysimum cheiranthoides treacle mustard. Two large plants in disturbed ground by Recycling Centre 1996.

Hesperis matronalis dame's-violet. In shrubbery by north wall 1995.

Barbarea vulgaris common wintercress. Single plant on disturbed ground near Waterfall 1996.

* *Rorippa palustris* marsh yellow-cress. 'Rubbish near Buckingham Palace' June 1833 (herb. York); 'Near Buckingham Palace' (Trimen & Dyer 1869: 28); in crack of North Terrace 1956 (Kent 1960: 45).

* *R. sylvestris* creeping yellow-cress. Plant by Flamingo site 1997.

Cardamine bulbifera coralroot. Several plants near Waterfall April 1998.

C. pratensis cuckoo flower. Established on south bank of Lake.

* *C. flexuosa* wavy bitter-cress. Occasional.

* *C. hirsuta* hairy bitter-cress. Locally abundant.

* *Capsella bursa-pastoris* shepherd's-purse. Occasional.

Thlaspi arvense field penny-cress. From bird-seed 1980 (DMcC). A plant on disturbed ground by Waterfall 1995; a few plants near Flamingo site 1997.

Lepidium virginicum least pepperwort. From bird-seed 1978 (Burton 1979: 67) (herb. E. J. Clement). V.

* *Coronopus squamatus* swine-cress (Kent 1960: 44).

* *C. didymus* lesser swine-cress. Near Recycling Centre 1999.

* *Brassica oleracea* cabbage. Single plants on disturbed ground by Lake 1995, 1997.

B. napus ssp. *oleifera* oil-seed rape. Single tall plant on West Terrace 1995, and 1997. V.

B. rapa turnip. From bird-seed 1978 (DMcC).

* *B. juncea* Chinese mustard. From bird-seed 1980 (DMcC).

* *Sinapis arvensis* charlock. Occasional by Recycling Centre and by Lake.

* *S. alba* white mustard.

* *Raphanus raphanistrum* wild radish (Kent 1960: 44).

Resedaceae

Reseda luteola weld. Single plant near Mudhole 1996.

Ericaceae

* *Calluna vulgaris* heather. In abandoned peat-bed near north wall 1995.

* *Erica ciliaris* Dorset heath.

* *E. tetralix* cross-leaved heath.

Primulaceae

* *Primula vulgaris* primrose. Planted but regenerating freely. On Mound, on Island, by north side of Lake and in Arboretum area.

P. veris cowslip. Planted on boat-house site, on Island and in Arboretum area.

* *Lysimachia vulgaris* yellow loosestrife. Probably planted (Eastwood 1953: 168, 175). Flourishing by Lake.

* *Anagallis arvensis* ssp. arvensis scarlet pimpernel. On disturbed ground near Waterfall 1995, by Flamingo site 1997.

Saxifragaceae

* *Saxifraga stolonifera* strawberry saxifrage.

Rosaceae

* *Filipendula ulmaria* meadowsweet. A few plants on Island.

Rubus polyanthemus bramble. 1985 (DMcC). On Mound 1995, 1998 (det. D. E. Allen). V.

* *R. laciniatus* cut-leaved bramble. On Mound.

* [*R. rubritinctus* bramble. Recorded as occasional 1960 - 1963, possibly in error.]

* *Potentilla anserina* silverweed (Kent 1960: 49).

* *P. reptans* creeping cinquefoil (not x *italica*, as recorded 1960 - 1963). Frequent. V.

* *Aphanes australis* slender parsley-piert (Kent 1960: 49 - recorded in error as *A. arvensis*). On Table.

Rosa caesia ssp. *glauca* (*R. afzeliana* aff. var. *glaucophylla* (Winch) Wolley-Dod) glaucous dog rose. Island 1985 (det. G. G. Graham) (Burton 1986: 198) and not seen since (herb. Sunderland).

* *R. canina* dog rose (Kent 1960: 49 as *R. dumetorum* and Kent 1975: 291 as *R. corymbifera*). Large bush on Island. V. These may all refer to the same species.

* *Prunus domestica* wild plum.

P. laurocerasus cherry laurel. Seedling in shrubbery by south-west wall 1995.

Sorbus aucuparia rowan. Seedling in shrubbery by north wall 1995.

* *Crataegus monogyna* hawthorn (Kent 1960: 50). In shrubbery by south-west wall 1995.

Fabaceae

* *Robinia pseudoacacia* false-acacia (Kent 1960: 48). Suckers.

* *Lotus corniculatus* common bird's-foot-trefoil (Kent 1960: 48). Plentiful by east bank of Lake and on Island. V.

* *Ornithopus perpusillus* bird's-foot (Kent 1960: 49).

* *Vicia cracca* tufted vetch (Kent 1960: 49). South-west side of Lake and on Island.

V. hirsuta hairy tare. In Arboretum. V.

* *V. tetrasperma* smooth tare. On Mound by Bombhole and in Arboretum. V.

V. sepium bush vetch. In Arboretum.

[*V. sativa* ssp. *sativa* common vetch. 1965 (Kent 1975: 262). Probably in error for the next species.]

V. sativa ssp. *segetalis*. On Mound by Bombhole, in Arboretum and by Lake opposite Flamingo site (det. R. M. Burton).

* *Lathyrus pratensis* meadow vetchling (Kent 1960: 49). On Island and south bank of Lake. V.

* *L. latifolius* broad-leaved everlasting-pea.

Ononis mitissima Mediterranean rest-harrow. From bird-seed 1980 (DMcC, herb. E.J. Clement). V.

Medicago lupulina black medick. 1966 (DMcC). Occasional. On Island, on south bank of Lake, in Yard 1995.

M. arabica spotted medick. On Mound near Bombhole.

* *Trifolium repens* white clover. Frequent.

* *T. hybridum* ssp. *hybridum* alsike clover (Kent 1960: 48). 1992 (DMcC). South bank of Lake 1998.

T. dubium lesser trefoil. (DMcC). Frequent.

T. hirtum rose clover. 1988 (DMcC).

T. micranthum slender trefoil. In Lawn 1995.

* *T. pratense* red clover. Now scarce.

T. lappaceum bur clover. From bird-seed 1982 (DMcC).

T. arvense hare's-foot clover. Near south end of Lake 1992 (DMcC). Still present.

* *Laburnum anagyroides* laburnum. Occasional seedlings.

* *Cytisus scoparius* broom.

Haloragraceae

* *Myriophyllum spicatum* spiked water-milfoil (Kent 1960: 50).

Gunneraceae

* *Gunnera manicata* giant-rhubarb. Planted by Lake 1959 and 1961, and still present.

Lythraceae

* *Lythrum salicaria* purple-loosestrife (Eastwood 1953: 168, 175; Lousley 1957: 15). 'In 1969 up to 7 feet 9 inches tall!' (DMcC). Flourishing around Lake.

Onagraceae

* *Epilobium hirsutum* great willow-herb. Occasional.

E. parviflorum hoary willow-herb. Single plant near Waterfall 1995.

* *E. montanum* broad-leaved willow-herb. Occasional.

* *E. lanceolatum* spear-leaved willow-herb. 1961 only - second record for Middlesex (Kent 1975: 83, 311).

E. tetragonum square-stalked willow-herb. Occasional. Single plants near Recycling Centre 1995 (det. G. Kitchener); opposite Flamingo site 1997; in Yard 1998.

* *E. roseum* pale willow-herb (Kent 1960: 50). Single plant in Yard 1995 (det. G. Kitchener).

* *E. obscurum* short-fruited willow-herb (Kent 1960: 50). Frequent.

* *E. ciliatum* American willow-herb. Frequent.

* *Chamerion angustifolium* rosebay willow-herb. Frequent.

Aquilifoliaceae

* *Ilex aquilifolium* holly. Occasional seedlings.

Euphorbiaceae

* *Mercurialis perennis* dog's mercury. Established on Mound by Back Path.

* *M. annua* annual mercury. Scarce.

Euphorbia helioscopia sun spurge. In hanging garden and near Waterfall 1995.

* *E. peplus* petty spurge. Occasional.

E. hirta L. asthma-plant. From bird-seed 1978 (Burton 1979: 67; Clement & Foster 1994: 200) (det. E. J. Clement).

Rhamnaceae

Rhamnus catharticus buckthorn (Kent 1960: 48).

Linaceae

* *Linum usitatissimum* linseed.

* *L. catharticum* fairy flax.

Hippocastanaceae

* *Aesculus hippocastanum* horse-chestnut (Kent 1960: 48).

A. indica Indian horse-chestnut. Single seedling near north wall 1997.

Aceraceae

* Acer pseudoplatanus sycamore. Frequent seedlings.

Simaroubaceae

Ailanthus altissima tree-of-heaven. Suckers on Mound.

Oxalidaceae

* *Oxalis corniculata* procumbent yellow oxalis. Occasional. Var. *atropurpurea* Planchon in Silver Garden.

O. stricta upright yellow oxalis. In Yard 1995.

O. acetosella wood sorrel. At edge of bed by Clock-tree Corner.

* *O. debilis* var. *corymbosa* large-flowered pink oxalis (Kent 1960: 47). In Rose Garden and near shed by north wall.

Geraniaceae

Geranium x oxonianum Druce's crane's-bill. Single plant among grasses on Mound near Ice-house 1995.

G. rotundifolium round-leaved crane's-bill. A colony by south-west wall near Recycling Centre. V.

G. dissectum cut-leaved crane's-bill. Occasional. V.

G. pusillum small-flowered crane's-bill. Path edge near Mudhole 1999.

* *G. molle* dove's-foot crane's-bill (Kent 1960: 47). Frequent. Some pale-flowered plants on Mound opposite Yard entrance (herb. Cambridge).

G. robertianum herb robert. Single plant by Waterfall 1997, plentiful 1998.

Araliaceae

* *Hedera helix* ssp. *helix* ivy. Noted on wall of Constitution Hill 1907, and elsewhere 1911. Currently in hanging garden, with ssp. *hibernica* and cultivars.

Apiaceae

* *Hydrocotyle vulgaris* marsh pennywort. Marshy edge of Lake (Eastwood 1953: 168, 175; Kent & Lousley 1953: 126; Lousley 1957: 15; Kent 1960: 50). Still well established. V.

* *Chaerophyllum aureum* golden chervil. (Lousley 1957: 15; Kent & Lousley 1957, vii: 349; Kent 1960: 51; 1962: 19). Locally plentiful. V.

C. temulum rough chervil. Single large plant near Arboretum 1996.

* *Anthriscus sylvestris* cow parsley. Frequent.

A. caucalis bur parsley. Near the Lake 1985 (Burton 1986: 198). On Island. V.

Scandix pecten-veneris shepherd's-needle. From bird-seed 1976 (DMcC).

* *Conopodium majus* pignut.

* *Oenanthe crocata* hemlock water-dropwort (Lousley 1957: 15; Kent 1960: 51). Locally frequent.

* *Aethusa cynapium* ssp. *cynapium* fool's parsley. Locally frequent.

Anethum graveolens dill. From bird-seed 1980 (DMcC).

Conium maculatum hemlock. Four tall plants by Recycling Centre 1995. V.

Sison amomum stone parsley. Two plants in hanging garden 1995-1999. V.

Ammi majus bullwort. From bird-seed c. 1980 (DMcC).

A. visnaga tooth-pick plant. From bird-seed c. 1980 (DMcC).

Pastinaca sativa parsnip. Three plants on west side of Lake 1967 (Lousley 1968: 9).

* *Heracleum sphondylium* hogweed. Occasional.

* *H. taxon*. A giant hogweed, with noticeable differences (McClintock 1968; Kent 1975: 338). Locally abundant, being reduced. V.

H. sphondylium x Buckingham Palace taxon. Rough shady ground near east end of Mound 11.ix.1974 (coll. DMcC., conf. W. Muirhead, herb. Edinburgh). V.

Torilis japonica upright hedge-parsley. 1985 (DMcC).

* *T. nodosa* knotted hedge-parsley (Kent 1960: 51).

Apocynaceae

* *Vinca minor* lesser periwinkle. Established on Mound.

Solanaceae

* *Lycium barbarum* Duke of Argyll's tea-plant.

* *Lycopersicon esculentum* tomato. Single plant in bed near Arboretum 1996. V.

* *Solanum nigrum* ssp. *nigrum* black nightshade. On disturbed ground near Waterfall 1995-1996.

* *S. dulcamara* bittersweet. Occasional. In shrubbery by south-west wall 1995; a fine white-flowered form in Yard to 1995 (conf. S. Knapp).

* *Nicotiana* sp. tobacco plant.

Convolvulaceae

* *Convolvulus arvensis* field bindweed. Scarce. Behind The Border 1995; on Mound.

* *Calystegia sepium* hedge bindweed. (Kent 1960: 53). Established by Firehole, occasional elsewhere. V.

* *C. silvatica* large bindweed. Established by Firehole. V.

Cuscutaceae

* *Cuscuta epithymum* dodder. On heather in peat blocks by Summer-house 1964 - 1966 (Kent 1975: 396).

Boraginaceae

Anchusa azurea garden anchusa. Garden escape In Yard 1995 - 1998.

Borago pygmaea slender borage. Garden escape in Yard 1995 - 1998. V.

Trachystemon orientalis Abraham-Isaac-Jacob. Good patch under weeping willow on Island 1996. New to Middlesex (Kent 1999).

Myosotis arvensis field forget-me-not. One plant on disturbed ground near Waterfall 1995.

Verbenaceae

* *Verbena bonariensis* Argentinian vervain. On disturbed ground by Waterfall 1995.

* *V. x hybrida* verbena.

Lamiaceae

Stachys officinalis betony. Planted colony persisting in Arboretum.

* *S. sylvatica* hedge woundwort. Near Mudhole 1999.

* *Ballota nigra* ssp. *meridionalis* black horehound. Occasional.

* *Lamium album* white dead-nettle. Occasional.

* *L. purpureum* dead-nettle. Occasional.

* *L. amplexicaule* henbit dead-nettle (Kent 1960: 55). On east end of Mound and by Back Path.

* *Galeopsis bifida* bifid hemp-nettle.

Scutellaria galericulata skullcap. By south margin of Lake; opposite Flamingo site 1997.

* *Ajuga reptans* bugle. Rare. Established on Island; West Terrace 1995. V.

* *Glechoma hederacea* ground ivy. On Island 1995. The Gallery Bank, where f. *rosea* Neuman had become well established, was later demolished.

* *Prunella vulgaris* self-heal (Kent 1960: 54). Occasional.

Thymus pulegioides large thyme. A few plants in old peat-bed behind Rose Garden (det. R. M. Burton). V.

* *Lycopus europaeus* gypsywort (Kent 1960: 54). Established around Lake.

* *Mentha arvensis* corn mint. East side of Lake 1967 (Kent 1975: 422). A patch near 'Cranes' on east side of Lake.

* *M. x gracilis* (*x gentilis*) bushy mint.

* *M. aquatica* water mint. On Island near Flamingo site 1997 (conf. R. M. Harley). V.

Plantaginaceae

* *Plantago major* ssp. *major* greater plantain. Occasional.

P. major ssp. *intermedia*. Lawn by Waterfall 1977 (Burton 1978: 79).

* *P. media* hoary plantain.

* *P. lanceolata* ribwort plantain. Occasional.

P. afra plantain. From bird-seed 1980 (DMcC).

Buddlejaceae

* *Buddleja davidii* butterfly-bush. Seedlings.

Oleaceae

* *Fraxinus excelsior* ash. Seedlings.

Scrophulariaceae

* *Verbascum thapsus* common mullein.

* *Scrophularia nodosa* common figwort. In shrubbery by south-west wall 1995; Mudhole 1997.

S. auriculata water figwort. At various waterside sites since at least 1991.

* *Mimulus moschatus* musk. By Catenary in Rose Garden.

Asarina procumbens trailing snapdragon. Well established near Yard since 1980. V.

Cymbalaria muralis ivy-leaved toadflax. A few plants on Yard wall.

Linaria purpurea purple toadflax. One plant near Hyde Park Corner 1997. V.

* *Kickxia elatine* sharp-leaved fluellen. A few plants on disturbed ground near Waterfall 1995. V.

K. spuria round-leaved fluellen. A few plants on disturbed ground near Waterfall 1995. V.

* *Digitalis purpurea* foxglove. Established on Island; one plant near 'Cranes' 1995.

* *Veronica serpyllifolia* thyme-leaved speedwell. Scarce.

V. chamaedrys germander speedwell. Locally frequent near Lake.

V. beccabunga brooklime. By Lake near 'Cranes' 1995; on damp refurbished soil near Flamingo site, and on wet pavement in Yard 1997.

V. catenata pink water-speedwell. Several plants on damp refurbished soil near Flamingo site 1997 (conf. J. Burnett). V.

* *V. arvensis* wall speedwell. Scarce. On Island.

V. agrestis green field speedwell. 1965 (DMcC) (Kent 1975: 414). On Island 1997. V.

V. polita grey field speedwell. On West Terrace 1991 (DMcC). V.

* *V. persica* common field speedwell (Kent 1960: 54). Occasional.

V. hederifolia ssp. *hederifolia* ivy-leaved speedwell. Single plant near Yard 1996. New to Middlesex (Kent 1999).

* *V. hederifolia* ssp. *lucorum* ivy-leaved speedwell. Occasional.

Orobanchaceae

Orobanche minor var. *minor* common broomrape. By south bank of Lake 1998, apparently on *Trifolium dubium* lesser trefoil. V.

Campanulaceae

Campanula rotundifolia harebell. Nursery stock planted on Mound about 1990 and persisting. V.

Lobelia erinus garden lobelia. On gravel of North Terrace 1965 - 1982 (DMcC).

Rubiaceae

* *Sherardia arvensis* field madder.

* *Galium aparine* cleavers. Occasional.

* *G. verum* lady's bedstraw. Long established on West Terrace and still plentiful (Burton 1996: 142).

G. saxatile heath bedstraw. On peat blocks 1965 - 1966; in lawn south-east of Waterfall 1989 (DMcC). In lawn near south bank of Lake 1995, between Arboretum and tennis court 1997.

Caprifoliaceae

* *Sambucus nigra* elder. Occasional seedlings.

Dipsacaceae

Dipsacus fullonum teasel. One plant at Mudhole 1996.

Asteraceae

* *Arctium minus* lesser burdock. Single large plant at Mudhole 1998.

Carduus crispus ssp. *multiflorus* welted thistle. One plant at Mudhole 1996.

* *Cirsium vulgare* spear thistle. Occasional.

* *C. arvense* creeping thistle. Occasional.

Onopordum acanthium cotton thistle. Several plants naturalized by Firehole.

* *Centaurea diluta* lesser star-thistle.

* *C. nigra* common knapweed. Scarce. Established on Island.

* *Lapsana communis* nipplewort. Frequent.

* *Hypochaeris radicata* cat's-ear. Frequent.

* *Leontodon autumnalis* autumn hawkbit. On west side of Lake and on West Terrace. V.

Picris echioides bristly ox-tongue. Occasional. 2m tall on Island 1995. V.

* *Tragopogon pratensis* ssp. *minor* goat's-beard. Occasional (Kent 1960: 57). A few plants near 'Cranes' 1995, by Bridge No. 2 1997.

* *Sonchus arvensis* perennial sow-thistle. Large colony by Recycling Centre.

* *S. oleraceus* smooth sow-thistle. Occasional.

* *S. asper* prickly sow-thistle. Occasional (Kent 1960: 57). V.

* *Lactuca serriola* prickly lettuce. 1979 - 1985 (DMcC). Several plants near Recycling Centre 1995.

Taraxacum hamatulum dandelion. West Terrace 1975 (DMcC) (det. A. J. Richards). V.

T. hamiferum. Mound 1993 (DMcC) (det. A. J. Richards). V.

T. acroglossum. North of Yard 1997 (det. A. J. Richards). V.

T. angustisquameum (probably). Mound 1998 (det. A. A. Dudman). V.

T. croceiflorum. Mound 1993 (DMcC) (det. A. J. Richards) V.

T. ekmanii. Mound 1997 (det. A. J. Richards). V.

T. sublaeticolor. Heather bed 1969 (DMcC) (det. A. J. Richards). Mound 1998 (det. A. A. Dudman). V.

T. tenebricans. Heather bed 1969 (DMcC) (det. A. J. Richards). V.

* *Crepis capillaris* smooth hawk's-beard. Occasional.

* *C. vesicaria* ssp. *taraxacifolia* beaked hawk's-beard. Two plants on West Terrace 1995.

Hieracium trichocaulon hawkweed. Locally plentiful near Lake. V.

* *H. lepidulum* Stenstr. var. *haematophyllum* Dahlst. hawkweed (Lousley 1958: 185; Kent 1960: 57, 1975: 494; Bellamy 1984: 171). Refound 1995, well established on north-east side of Lake. V.

H. umbellatum. 1991 (DMcC).

* *Gnaphalium uliginosum* marsh cudweed (Kent 1960: 56). Two plants north of Yard 1995.

* *Pulicaria dysenterica* common fleabane. East side of Lake 1969 (Kent 1975: 465). By Lake near 'Cranes'.

* *Telekia speciosa* yellow ox-eye.

* *Solidago altissima* Canadian golden-rod.

* *S. gigantea* early golden-rod.

Aster x versicolor late Michaelmas-daisy. One plant by Lake near Mudhole 1995 and 1998 (det. R. M. Burton). V.

* *A. novi-belgii* confused Michaelmas-daisy.

Erigeron acer blue fleabane. Three plants on West Terrace 1996. V.

* *Conyza canadensis* Canadian fleabane. Frequent.

C. sumatrensis Guernsey fleabane. Less frequent.

* *Bellis perennis* daisy. Frequent; f. *discoidea* Hus by Waterfall 1988 (DMcC). Recently much affected by the Australian rust fungus *Puccinia distincta.*

* *Artemisia vulgaris* mugwort. Plants near Flamingo site, in The Border, and by Lake 1997.

* *Achillea millefolium* yarrow. Frequent.

* *Chamaemelum nobile* chamomile. Locally frequent, probably native, in lawns (Kent 1960: 56; McClintock 1977.). Still locally frequent.

* *Anthemis cotula* stinking chamomile.

* *Leucanthemum vulgare* ox-eye daisy (Kent 1960: 57). Abundant on Island. V.

* *Matricaria recutita* scented mayweed. Frequent.

* *M. discoidea* pineapple-weed. Near Waterfall 1992 (DMcC).

* *Tripleurospermum inodorum* scentless mayweed. By Recycling Centre 1995. V.

* *Senecio doria* golden ragwort.

* *S. jacobaea* common ragwort (Kent 1960: 56). Occasional.

* *S. squalidus* Oxford ragwort. Occasional.

* *S. vulgaris* groundsel. Frequent.

* *S. viscosus* sticky groundsel (Kent 1960: 56).

* *Tussilago farfara* colt's-foot. Established near Waterfall.

* *Petasites fragrans* winter heliotrope. Large well-established male colony on Mound above Ice-house. V.

* *Guizotia abyssinica* niger.

* *Galinsoga parviflora* gallant-soldier. Dussan 1916 (Druce 1917; Lousley 1957: 15). Occasional.

* *G. quadriradiata* shaggy soldier (Lousley 1957: 15). Locally frequent.

Eupatorium cannabinum hemp agrimony. Single plant near Flamingo site 1997.

Alismataceae

* *Alisma plantago-aquatica* water-plantain. Noted by Eastwood (1953: 175) but possibly gone in 1963.

Araceae

* *Acorus calamus* sweet-flag (Lousley 1957: 15). Near Steps to Lake.

* *Arum maculatum* lords-and-ladies (Kent 1960: 58). A plant at east end of The Border 1998.

* *Arisarum proboscideum* mouse-tail-plant. One plant behind Tea-house 1960 - 1963, gone by 1975 (DMcC).

Commelinaceae

* *Tradescantia zebrina* wandering sailor.

Juncaceae

* *Juncus tenuis* slender rush.

* *J. bufonius* toad rush. Occasional by Lake. V.

* *J. articulatus* jointed rush.

* *J. inflexus* hard rush. In heather bed 1992 (DMcC).

* *J. effusus* soft-rush. Near Steps to Lake and by Waterfall 1995. V.

* *Luzula campestris* field wood-rush (Kent 1960: 58). Near west bank of Lake.

Cyperaceae

* *Eleocharis palustris* common spike-rush (Kent 1960: 59).

* *Bolboschoenus maritimus* sea club-rush (Lousley 1957: 15; Kent 1960: 58; 1975:547). V.

* *Schoenoplectus lacustris* common club-rush (Kent 1960: 58). Established by south end of Lake.

* *Cyperus longus* galingale. Various sites by Lake.

* *Carex ovalis* oval sedge.

* *C. hirta* hairy sedge (Kent 1960: 59). A few plants on Table. V.

* *C. acutiformis* lesser pond-sedge (Lousley 1957: 15; Kent 1960: 59). A few plants by south and south-east margins of Lake (det. R. M. Burton). V.

C. pendula pendulous sedge. Three plants 1967 (Lousley 1968: 9). On Island near Bridge No. 1.

* *C. acuta* slender tufted-sedge (Lousley 1957: 15; Kent 1960: 59). By south margin of Lake (det. R. M. Burton). V.

Poaceae

* *Festuca pratensis* meadow fescue (Kent 1960: 59).

* *F. arundinacea* tall fescue (Kent 1960: 59). A few plants near Bridge No. 1.

* *F. rubra* (sensu lato) red fescue. Frequent. V.

* *F. ovina* (sensu lato) sheep's-fescue.

* *Lolium perenne* perennial rye-grass. Frequent.

* *L.* x *boucheanum* (*L. perenne* x *L. multiflorum*) hybrid rye-grass.

L. multiflorum Italian rye-grass. A few plants. V.

Vulpia bromoides squirrel-tail fescue. On Island. V.

V. myuros rat's-tail fescue. Locally abundant in Arboretum. V.

* *Cynosurus cristatus* crested dog's-tail (Kent 1960: 59). Occasional. V.

* *Poa annua* annual meadow-grass. Plentiful.

* *P. trivialis* rough meadow-grass (Kent 1960: 59). Occasional.

* *P. pratensis* smooth meadow-grass. Occasional.

* *P. nemoralis* wood meadow-grass (Kent 1960: 59).

* *Dactylis glomerata* cock's-foot. Frequent, covering much of Mound.

* *Glyceria maxima* reed sweet-grass (Lousley 1957: 15; Kent 1960: 60).

Arrhenatherum elatius ssp. *elatius* false oat-grass. Occasional tussocks.

* *Trisetum flavescens* yellow oat-grass. Occasional along north side of Lake and in Arboretum. V.

* *Deschampsia cespitosa* tufted hair-grass.

* *Holcus lanatus* Yorkshire fog (Kent 1960: 60). Frequent.

* *H. mollis* creeping soft-grass (Kent 1960: 60). Occasional.

Aira caryophyllea ssp. *multiculmis* silver hair-grass. Locally abundant in Arboretum (det. R. M. Burton).

* *Anthoxanthum odoratum* sweet vernal grass (Kent 1960: 60). Occasional.

* *Phalaris arundinacea* reed canary-grass (Kent 1960: 60).

P. canariensis canary-grass. From bird-seed 1980 (DMcC).

* *Agrostis capillaris* common bent. Frequent. V.

A. x *murbeckii* (*A. capillaris* x *A. stolonifera*). Pre-1988 (DMcC) (det. T. Cope, herb. Kew). V.

* *A. gigantea* black bent. On Island and near 'cranes'. V.

* *A. stolonifera* creeping bent. Occasional.

A. scabra rough bent. One large plant 1967 (Kent 1975: 637). V.

* *Alopecurus pratensis* meadow foxtail (Kent 1960:60). Occasional.

* *A. geniculatus* marsh foxtail (Kent 1960: 60).

A. myosuroides black-grass. Occasional since 1991.

* *Bromus hordaceus* soft-brome. Frequent.

Anisantha sterilis barren brome. Occasional.

* *Elytrigia repens* common couch. Occasional.

Hordeum distichon two-rowed barley. One plant by Recycling Centre 1996.

H. secalinum meadow barley. Single plant 1997.

Triticum aestivum bread wheat. Two plants 1995.

* *Cortaderia selloana* pampas-grass.

* *Molinia caerulea* purple moor-grass. Introduced with peat blocks 1964 (Kent 1975: 563).

* *Phragmites australis* common reed (Lousley 1957: 15; Kent 1960: 59). Established by Lake, perhaps planted.

Eleusine tristachya American yard-grass. From bird-seed 1980 (DMcC, hb. E. J. Clement). V.

Panicum miliaceum common millet. From bird-seed 1974, 1978, 1982 (DMcC).

Echinchloa utilis Japanese millet. From bird-seed 1974, 1980 - 1982 (DMcC).

Setaria viridis green bristle-grass. From bird-seed 1981 - 1982 (DMcC).

Digitaria ischaemum smooth finger-grass. In Yard on introduced soil 1997. V.

D. ciliaris tropical finger-grass. From bird-seed 1976 - 1978; in quantity 1980 - 1982 (DMcC).

Typhaceae

* *Typha latifolia* bulrush. Planted 1902, exterminated by 1960 (Kent 1975: 544).

T. angustifolia lesser bulrush. Established by south side of Lake.

Liliaceae

Convallaria majalis lily-of-the-valley. A patch by west side of Lake.

Ornithogalum angustifolium star-of-Bethlehem. Among daffodils near Mudhole 1998. V.

* *Scilla siberica* Siberian squill. On Island.

* *Hyacinthoides non-scripta* bluebell. Occasional.

* *H. non-scripta* x *H. hispanica* hybrid bluebell. Locally abundant.

* *H.hispanica* Spanish bluebell. Occasional.

* *Allium moly* golden garlic. Long established above Ice-house. V.

A. ursinum ramsons. At base of tree near Bridge No. 1 from 1996.

Tristagma uniflorum (*Ipheion uniflorum*) spring starflower. In Yard 1996.

Iridaceae

* *Iris pseudacorus* yellow iris. (Eastwood 1953: 175). Established at several sites around Lake.

I. foetidissima stinking iris. A clump at rear of The Border 1997.

Orchidaceae

Dactylorhiza fuchsii common spotted orchid. Single plant by Lake near 'cranes' 1995-1999. A dozen plants by Lake near Mudhole, among transplanted iris clumps 1998; thirty flowering spikes in 1999.

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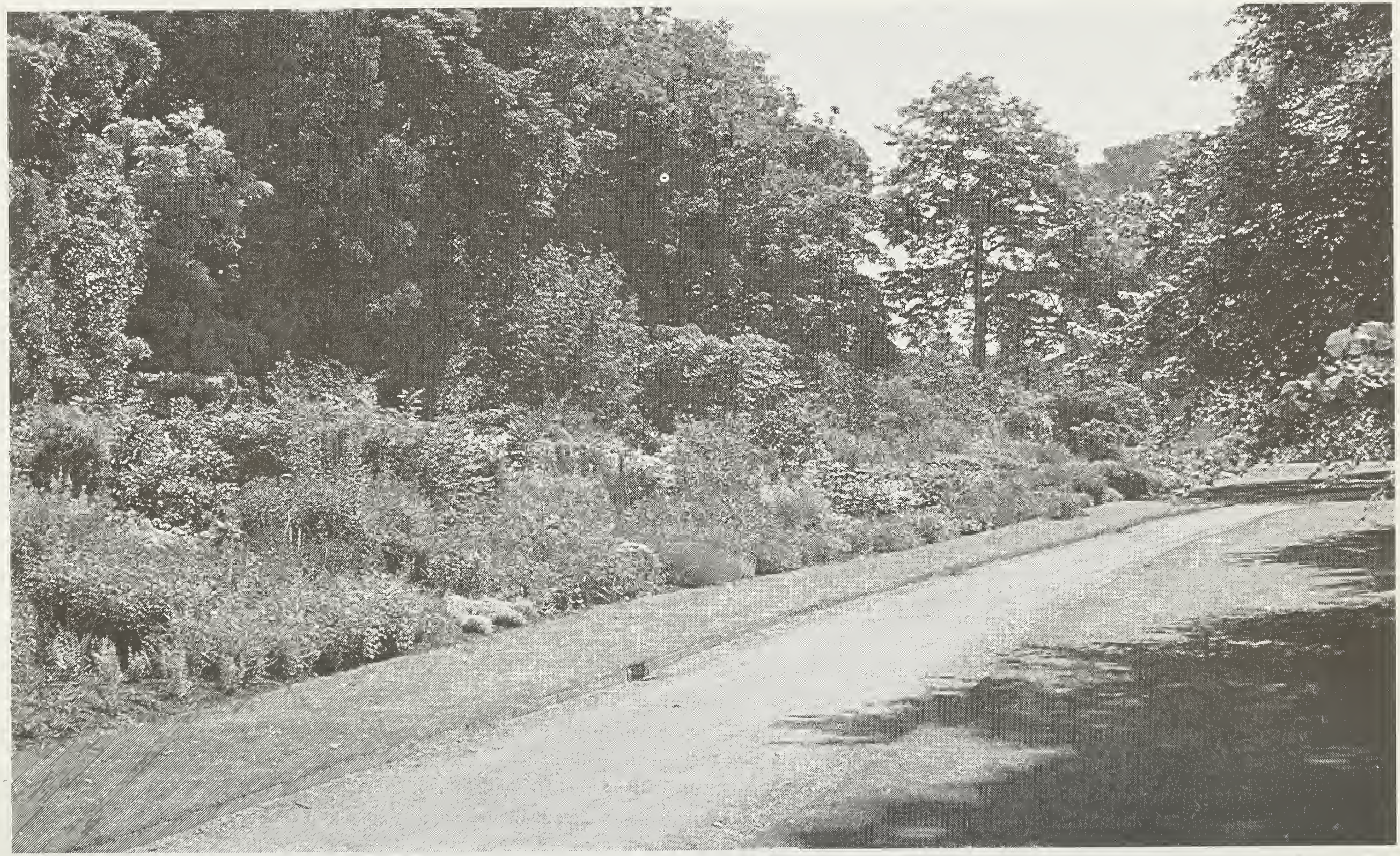

PLATE A. Buckingham Palace Garden, London. View of The Border, towards the Palace, August 1999. *Photographed by Mark Lane.*

Garden plants in Buckingham Palace Garden

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The 3,650 cultivated plants in the Garden represent a wide range and diversity and there are too many to list here. However, we have selected the most appropriate plants to exemplify the variety. The mix of plants ranges from the native to the exotic and from the tree to the waterlily and fern. The Garden benefits from the effect of the centre of town remaining a few degrees warmer than the surrounding countryside. This produces less severe and shorter-lasting frosts and a higher average mean temperature creating an advancement of the season, usually by three weeks.

Recording history

No accession or planting records exist prior to the mid 1950s. Evidently they were not considered too important. An interesting comment comes from Mr Thomas Hay, a previous Royal Parks Superintendent, and helps us to understand why there are so few records of older plantings — 'I do not think it worthwhile naming trees like Cherry and Magnolia as they are small and don't last long'. The only indication of age of some of the trees is the plaque, if the tree was planted for a special occasion. The noting of the garden plants by the three previous Head Gardeners and by ourselves has, however, been ongoing since the last survey, which began in 1961.

The survey from 1961 to 1963 (McClintock 1964), listed 509 woody plants and 235 herbaceous plants and bulbs. At present, there are some 2,400 different woody plants, 850 herbaceous, 200 bulbs and 100 roses with 100 other plants in the lean-to glasshouse. All of the areas in the Garden were surveyed between 1995 and 1997. The explanation for the disparity in numbers between the two surveys is partly accounted for by the inclusion of many new and rare species into the collection, accommodated in the new beds and borders formed both by the removal of old plantings and the creation of more. The Border, which runs parallel to Constitution Hill, no longer includes seasonal bedding and instead is planted with herbaceous plants, bounded to the east by shrubs.

Throughout this work references and sources to names have been taken from *The plant finder* (Royal Horticultural Society, 1998/9).

Summary of findings

Trees

Although one hundred mature elms were removed from the Garden as a consequence of Dutch elm disease (the last in 1980), and the Garden also lost six mature trees in the 1987 and 1990 storms, trees remain the dominant feature. The most numerous species is the London plane *Platanus* x *hispanica*. Some of these trees are likely to date back to the early nineteenth century. A specimen of *Platanus* 'Augustine Henry' was found amongst these. This is an uncommon plane, which is rare except in central London. An avenue of Indian chestnut *Aesculus indica* and a circle of Lombardy poplar *Populus nigra* var. *italica* were planted in the early 1960s to provide a screen from the new high-rise buildings. A tree with a strangely shaped trunk, originally thought to be a sweet chestnut, was identified by Alan Mitchell as the very rare Chinese chestnut *Castanea mollissima*. The round-leaved beech *Fagus sylvatica* 'Rotundifolia' is another rare tree in central London. The Chinese *Photinia beauverdiana* var. *notabilis* in the Tea

House Bed was literally overlooked until quite recently, because its foliage was hidden by the rhododendrons and its trunk inconspicuous below. A young specimen of olive *Olea europaea* produced fruit for the first time in 1997.

During recent years some choice oaks have been planted, among them the Louisiana oak *Quercus* x *ludoviciana*, water oak *Q. nigra*, black-jack oak *Q. marilandica* and Lucombe oak *Q.* x *hispanica* 'Lucombeana'.

Native trees cultivated in the Garden are alder *Alnus glutinosa*, dwarf birch *Betula nana*, silver birch *Betula pendula*, hornbeam *Carpinus betulus*, hawthorn *Crataegus monogyna*, beech *Fagus sylvatica*, ash *Fraxinus excelsior*, grey poplar *Populus canescens*, wild cherry *Prunus avium*, English oak *Quercus robur*, crack willow *Salix fragilis*, whitebeam *Sorbus aria*, rowan *Sorbus aucuparia*, wild service tree *Sorbus torminalis*, lime *Tilia* x *europaea*, wych elm *Ulmus glabra* (as suckers) and English elm *U. procera* (as suckers). Recent plantings include black poplar *Populus nigra* (female) and aspen *Populus tremula*.

Beside these, there are fine specimens of sycamore *Acer pseudoplatanus*, tree of heaven *Ailanthus altissima*, strawberry trees *Arbutus* x *andrachnoides* and *A. unedo*, golden Indian bean tree *Catalpa bignonioides* 'Aurea', purple beech *Fagus sylvatica* Purpurea group, narrow-leafed ash *Fraxinus angustifolia* var. *lentiscifolia*, golden ash *Fraxinus excelsior* 'Jaspidea', mulberry *Morus nigra*, poplars *Populus* x *canescens*, *P.* x *canadensis* 'Aurea', *P. nigra* var. *betulifolia* and *P. trichocarpa*, Turkey oak *Quercus cerris* and pagoda tree *Sophora japonica*.

Frost-tender trees include *Alangium chinense* and bead tree *Melia azederach*.

Some which are rare in cultivation are Italian maple *Acer opalus*, red bud maple *Acer trautvetteri*, *Alnus* x *spaethii*, *Betula cordifolia*, *B. livinovii* and *B. luminifera*, pecan *Carya illinoinensis*, hackberry *Celtis occidentalis* var. *pumila*, *Crataegus armena* and *C. macranthera*, *Ehretia dicksonii*, *Ilex corallina*, Himalayan holly *I. dipyrena*, tanbark oak *Lithocarpus densiflorus*, red beech *Nothofagus fusca*, white oak *Quercus alba*, *Q. aliena*, Japanese emperor oak *Q. dentata*, *Q. glandulifera*, *Q. infectoria*, *Q.* x *libanerris* 'Rotterdam' and *Sassafras albidum*.

Conifers

These make up only a small part (2.6 per cent by species) of the contents of the Garden. Leyland cypress x *Cupressocyparis leylandii*, is placed to baffle the wind that funnels down the adjoining streets of Belgravia. Originally a group of three, they were thinned in 1980 to single specimens.

Native conifers cultivated in the Garden are Scots pine *Pinus sylvestris* and yew *Taxus baccata*.

Good, but relatively young specimens exist of the incense cedar *Calocedrus decurrens*, blue Atlas cedar *C. libani* ssp. *atlantica* Glauca group, deodar *C. deodara*, Arizona cypress *Cupressus arizonica*, larch *Larix decidua*, dawn redwood *Metasequoia glyptostroboides*, Japanese black pine *Pinus thunbergii*, Californian redwood *Sequoia sempervirens*, giant sequoia *Sequoiadendron giganteum*, swamp cypress *Taxodium distichum*, noble cypress x *Cupressocyparis notabilis* and Irish yew *Taxus baccata* 'Fastigiata'.

New plantings within the last ten years are Nootka cypress *Chamaecyparis nootkatensis*, bishop pine *Pinus muricata*, Monterey pine *Pinus radiata*, Bhutan pine *Pinus wallichiana*, pond cypress *Taxodium distichum* var. *imbricatum* 'Nutans', *Taxus baccata* 'Dovastoniana' and Japanese yew *T. cuspidata*. A yew *T. baccata* hedge was installed opposite the Silver Border in 1993 to replace old privet.

Shrubs

The most plentiful shrub in the Garden has long been the native holly *Ilex aquifolium*, with over 250 of them. They are mostly Victorian plantings, and clothe large areas of the Garden near Grosvenor Place and Constitution Hill, providing significant cover on The Mound. The privet, *Ligustrum ovalifolium* and spotted laurel *Aucuba japonica* 'Variegata' — Victorian plantings that dominated the shrubberies — have largely been removed over the past forty years and have been replaced with a wide variety of others shrubs. Plantings during this time have included many more evergreen shrubs with colourful flowers like rhododendrons and camellias. There is now a notable collection that provides colour and interest all year round. A dozen new beds have been planted in recent years. Along the Back Path are a number of old lilacs, one of which was identified as *Syringa* x *hyacinthiflora* 'Plena', very scarce in Britain with mature specimens known at only two other sites.

Native shrubs that are cultivated in the Garden are bog rosemary *Andromeda polifolia*, bearberry *Arctostaphylos uva-ursi*, box *Buxus sempervirens*, dogwood *Cornus sanguinea*, hazel *Corylus avellana*, mezereon *Daphne mezereum*, spindle tree *Euonymus europaeus*, sea buckthorn *Hippophae rhamnoides*, honeysuckle, *Lonicera periclymenum*, blackthorn *Prunus spinosa*, sweet briar *Rosa rubiginosa*, goat willow *Salix caprea*, elder *Sambucus nigra*, wayfaring tree *Viburnum lantana* and guelder rose *Viburnum opulus*.

Fine specimens include the green manzanita *Arctostaphylos patula*, *Azara serrata*, cornelian cherry *Cornus mas*, *Euonymus japonicus*, the hedgehog holly *Ilex aquifolium* 'Ferox', bay *Laurus nobilis*, *Magnolia delaveyi* and the Rouen lilac *Syringa* x *chinensis*.

The British Isles have an equable oceanic climate and as a result plants from many parts of the world can be grown. Hardiness zones are based on the average annual minimum temperature for each area (Krüssmann 1960):

Z9 = -7°C to -1°C

Z10 = -1°C to +5°C

Plants happily growing in the Garden that are at the lower end of the limit of hardiness are *Atherosperma moschatum* (Z9), camphor tree *Cinnamomum camphora* (Z9), ivy of Paraguay *Cissus striata* (Z10), lily of the valley tree *Clethra arborea* (Z9), *Coprosma robusta* (Z9), *Coronilla valentina* ssp. *glauca* (Z9), *Dichroa febrifuga* (Z10), *Dregea sinensis* (Z9), Chilean jasmine *Mandevilla laxa* (Z9), banana shrub *Michelia figo* (Z9), *Retama monosperma* (Z9), *Rhododendron dalhousiae* var. *rhabdotum* (Z9), *Ribes viburnifolium* (Z9) and *Ugni molinae* (Z9).

Scarce plants in the Garden are *Acer oliverianum*, Sitka alder *Alnus sinuata*, *Berberis congestiflora* and *B. holocraspidon*, *Betula apoiensis* and *Betula potaninii*, *Camellia fraterna*, *Clethra fargesii* and *C. monostachya*, *Cotoneaster atropurpureus* and *C. lucidus*, *Crataegus canbyi* and *C. jonesiae*, *Eleutherococcus sieboldianus*, *Eurya japonica*, *Fremontodendron californicum* ssp. *decumbens*, *Gaylussacia ursinum*, *Hydrangea scandens*, *Ligustrum sempervirens*, *Lindera umbellata*, *Loropetalum chinense*, *Mahonia gracilipes*, *M. mairei*, x *savillii* and *M. wilcoxii*, *Neviusia alabamensis*, *Orixa japonica*, *Osmanthus suavis*, *Philadelphus intectus*, *Pseudocydonia sinensis*, *Pseudopanax delavayi*, deer oak *Quercus sadleriana*, fragrant sumach *Rhus aromatica*, *Ribes hudsonianum*, *Spiraea gemmata*, storax *Styrax americanus* and sheepberry *Viburnum lentago*.

Although a stout wall surrounds the Garden, little of it is used for the cultivation of wall shrubs or climbers. Up to the 1930s, the wall between the Garden and the Royal Mews was clothed in ivies. This was replaced with *Forsythia*, *Chaenomeles*, *Escallonia*, *Cotoneaster* and *Pyracantha* which have been trained on wires. In 1993, more plants were added to the internal walls that extend from Electrician's Gate to the Back Path and are visible to the visitors during summer opening. These include *Ampelopsis brevipedunculata* 'Elegans', *Berchemia racemosa*, *Bignonia capreolata*, *Clematis armandii*, *Hydrangea seemanii*, *Kadsura japonica*, *Pileostegia viburnoides*, *Stauntonia hexaphylla* and *Trachelospermum jasminoides* 'Wilsonii'.

Roses

Most roses in the Garden are grown in the Rose Garden and this area contains formal island beds of hybrid tea and floribunda roses, with a long border behind the Admiralty Summerhouse with shrub and species roses. Climbing roses are grown over a catenary made up of columns and ropes. The ghost rose *Rosa fedschenkoana* is represented by a good specimen as well as *Rosa webbiana*.

Herbaceous plants

The Border situated along part of the eastern edge of the Garden parallel to Constitution Hill is designed to flower during the summer and this show continues into the autumn. The waterfall beds contain many new additions to the list and these produce colour and texture throughout the summer. Since their introduction, some of the herbaceous plants have successfully spread, including red baneberry *Actaea rubra*, *Anemone trifolia*, *Aquilegia canadensis*, lily of the valley *Convallaria majalis*, wild bleeding heart *Dicentra formosa*, snow poppy *Eomecon chionantha*, *Geranium nodosum*, lenten rose *Helleborus orientalis*, *Iris setosa* var. *arctica*, *Lamium orvala*, *Leptinella squalida*, fringed loosestrife *Lysimachia ciliata*, gooseneck loosestrife *L. clethroides*, *Mitella breweri*, *Pachyphragma macrophyllum*, *Persicaria alata*, Solomon's seal *Polygonatum* x *hybridum*, comfrey *Symphytum grandiflorum*, *Thymus rotundifolius*, toad lily *Tricyrtis formosana*, northern blue violet *Viola septentrionalis* and smooth yellow violet *V. pubescens* var. *eriocarpa* mixed with woolly blue violet *V. sororia* 'Freckles'.

Rarities include *Asclepias incarnata* 'Alba' and *Lomandra longifolia*.

There are no rock garden or alpine plants because the nature of the Garden is unsuitable.

Ferns

Most ferns are a recent addition to the Garden, where only the royal fern remains from the last survey's recordings. Some of the new plantings have spread, such as the American maidenhair fern *Adiantum pedatum*, hart's-tongue fern *Asplenium scolopendrium*, Japanese shield fern *Dryopteris erythrosora*, oak fern *Gymnocarpium dryopteris*, shuttlecock fern *Matteuccia struthiopteris*, sensitive fern *Onoclea sensibilis*, hard shield fern *Polystichum aculeatum*, *P. makinoi* and woodsia *Woodsia obtusa*.

Grasses, sedges and bamboo

Occasional plantings of this category include *Carex muskinguemensis*, *Hakonechloa macra* 'Aureola', *Imperata cylindrica* 'Rubra', lyme grass *Leymus arenarius*, switch grass *Panicum virgatum* 'Rubrum', gardener's garters *Phalaris arundinacea* 'Picta', *Phyllostachys viridiglaucescens* and golden oats *Stipa gigantea*.

Bulbs

Those that have naturalised are *Allium* x *hollandicum*, Neapolitan garlic *A. neopolitanum*, round-headed leek *A. sphaerocephalum*, wood garlic *A. ursinum*, *Anemone blanda*, winter aconite *Eranthis hyemalis*, snake's-head fritillary *Fritillaria meleagris*, *Ipheion uniflorum*, grape-hyacinth *Muscari armeniacum* and *M. neglectum*.

Conclusion

A lesson can be learned from the demise of the elm tree, and that is to vary the content of a garden and not be too reliant upon one species. Present tree and shrub planting involves the incorporation of a much wider selection. Few conifers are planted, because of the need to maintain the Garden 'in keeping' with a broadleaf planting policy that more suits the surroundings. Increasing the general plant collection is an important development allowing the Garden to become notable in its own right and providing a display of colour throughout the year.

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A survey of the fish population in Buckingham Palace Garden lake

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Abstract

Seine-netting and electro-fishing surveys of the Buckingham Palace Garden lake demonstrated that the fish population was of low species diversity and density with low to normal growth rates. The population was dominated by roach *Rutilus rutilus*, with smaller numbers of gudgeon *Gobio gobio* and perch *Perca fluviatilis*. Isolation and eutrophication are suggested to be key factors in structuring the composition of fish populations in Buckingham Palace Garden lake.

Introduction

Buckingham Palace Garden lake is unusual in several ways. It is a small lake maintained for purely ornamental purposes and is subject to only limited human impact. Although situated within the heart of the capital, it is unaffected by the increasing demand for lakes to be managed as locations for sporting pursuits. It could be considered an island within a 'sea' of urbanization.

Buckingham Palace and its Garden were remodelled as a private royal residence in the late eighteenth century. The lake was constructed as part of an informal parkland landscape (Anon 1993). Maintenance of water quality soon proved to be a problem. In 1854 the lake was due to be drained and converted into flowerbeds when the water source was found to be impure. Arrangements were made, however, to provide a clean water supply from an artesian well on Duck Island, St James's Park. Fish were introduced soon after, although they had to be relocated to Kensington Gardens in 1869 when the lake was concreted. Problems with water quality continued so that the lake was suspected to be a source of typhoid at Buckingham Palace in the hot summer of 1883, until an 'expert' sampled the water and declared it to be 'of excellent quality for dietetic purposes'. Regular maintenance improved water quality and, in 1941, the job of draining and cleaning was efficiently carried out by a gang of German prisoners of war (Coats 1978). The Royal Family have enjoyed the lake, both as part of a good view and for moments of relaxation. Queen Victoria, Prince Albert and their children regularly fed the wildfowl on the lake. As Royal Princesses, Elizabeth and Margaret showed great interest in the wildlife of the Garden and ensured that the royal fish were fed with regular supplies of water fleas, *Daphnia*, delivered in frozen portions by the 'flea man' (Peacock 1951). The walls built around the Garden have provided privacy for the Royal Family and created a protected enclave for the wildlife within.

As Buckingham Palace Garden lake is so isolated, it may be considered to possess many of the faunal characteristics of small oceanic islands. Within such habitats, species diversity and the probability of species extinction are likely to be influenced by habitat size (area) and the degree of isolation (MacArthur & Wilson 1967). Under natural circumstances, fish communities within isolated lake habitats, especially those of recent origin, tend to show poor species diversity because of difficulties of colonisation. Such isolated fish populations may fluctuate as a consequence of natural oscillations and cycles in breeding success, even to the point of population extinction. Unlike natural isolated lakes, however, Buckingham Palace Garden lake is buffered from many of the extreme environmental conditions such as drought or winter-kill that can influence fish population structure and composition. The impact of drought or lowering of the water level is reduced by supplementation with tap water. Additionally, the 'London heat island' effect serves to minimise the likelihood of prolonged freezing and consequent winter-kill.

In England and Wales, ponds and lakes may be spatially isolated, but they are not wholly subject to natural processes because they are accessible to human interference. Such water bodies are often popular resources, used for a variety of recreational activities and are therefore subject to management regimes. Angling constitutes the most popular participation sport in England, and thus many water bodies are maintained as fisheries. Management priorities frequently involve the introduction and maintenance of popular sporting fish populations, some of which may be non-endemic species, such as carp *Cyprinus carpio*, that may not be beneficial to lentic ecosystems. This form of management has become more prevalent with increasing urbanization of land around water bodies — the expansion of the human population resulting in a concomitant increase in the demand for recreational facilities. Fish populations at these sites are augmented by legal and illegal introductions and well-intentioned disposal of spare live-bait, unwanted pets and jam-jars of 'tiddlers' by the general public, particularly children acting under parental edict.

The high security walls of Buckingham Palace exclude the constant pressure of human interference and the lake is not subject to fisheries management. It is this very isolation and inaccessibility that makes it such an interesting habitat to study. A survey of the fish population within the lake at Buckingham Palace Garden was commissioned by the London Natural History Society and undertaken during the spring and summer of 1996. The purpose of the survey was to identify the fish species present within the lake and to investigate their status in terms of abundance, growth rates and condition.

Site description

The lake is of irregular shape and has an area of 1.56 hectares (Figure 1). Two islands are present; the larger, a rough oval approximately 93 metres across its longest axis, forms a central landmass around which the main body of the lake is curved. It is connected to the bank by two bridges. The smaller island, more nearly circular in shape and approximately 13 metres in diameter, is located slightly to the south of the larger island and is unconnected to the bank. Both are vegetated and have trees growing upon them. The immediate surrounds of the lake comprise a mixture of formal garden including standard and ornamental trees, extensive lawns and some areas of habitat managed for wildlife (Page 1984). In addition to the bridges, two structures abut the lake; a set of stone steps and the foundations of a boathouse.

The lake is shallow with an average depth of less than 1.5 metres. The benthic substrate comprises thick, black silt mixed with twigs and organic debris, presumably from trees surrounding or overhanging the water. At the time of sampling the major water source was artesian well water pumped from St James's Park, supplemented by precipitation and runoff from the Garden. This supply was discontinued, however, in 1997 due to degradation of pipework (pers. comm. Mrs Jennifer Adams, LVO, The Royal Parks). A pump extracts the water from the south-eastern end of the lake via a grilled intake. The water re-enters by means of a waterfall at the end of the north-western arm of the lake. The pipe carrying the water is located within the lake, under the surface of the water, running from one end of the lake to the other. Measurement of the physico-chemical parameters of water samples taken on 14 April 1996 showed conductivity was 730 µS, pH 8.4, calcium hardness 115 mg/l and carbonate hardness 3.6 SBVµM/l. The water was green and turbid (Secchi depth 38 cm) and appeared eutrophic.

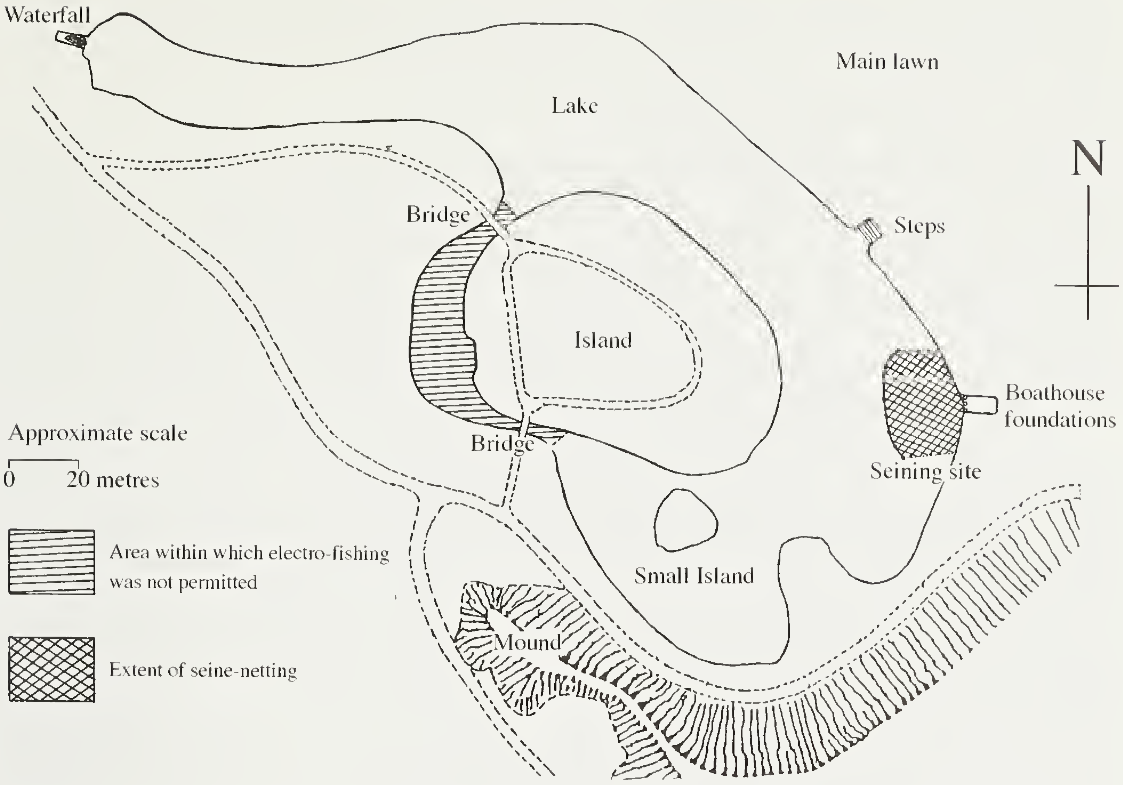

Figure 1: Buckingham Palace Garden lake, showing seining site.

There were no submerged macrophytes within the lake. Emergent and floating macrophytes such as *Sparganium* sp. and *Iris* sp. and some small beds of waterlilies *Nymphaea* sp., were located mainly within the north-western arm of the lake, below the waterfall. Macroinvertebrates appeared scarce within the lake, those found in the survey by Plant (in press) consisting of Heteroptera typically associated with organically-enriched, highly eutrophic waters (Sládečk & Sládečková 1994).

Methods

Sampling

Seine-netting was carried out on 5 May 1996 from the site of the old boat house on the eastern bank (Figure 1). The site was chosen to encompass the greatest variation in depth and the largest, easily-netted expanse of open water. The seine-net employed was 25 metres long, 2 metres deep, with 3 mm micromesh. The net was laid parallel to, and approximately 15 m from, the shore from a rowing boat. The total netted area was 360 m^2. The net was hauled inshore with minimum disturbance, an operator in a dry-suit ensuring that the floatline remained at the surface and leadline on the bottom to prevent escape of enclosed fish. The net was hauled onto the bank for sorting of captured fish. These were identified, measured (fork length to nearest mm), weighed (to nearest gm) and three to five scales collected from the appropriate location on the left flank, depending on species (Steinmetz & Müller 1991) before being returned to the lake. Six roach were in poor condition and were taken to the laboratory for autopsy.

A qualitative, electro-fishing survey was undertaken on 30 June 1996 to confirm the species composition of the fish population indicated by the quantitative seining. Electro-fishing was carried out by three operators in a rowing boat, one rowing, one netting immobilized fish, and the third operating a battery-powered, 12v pulsed DC, portable electro-fisher. All accessible portions of the lake were surveyed over a three-hour period. Immobilized fish were netted, identified, examined for external evidence of pathogens and were immediately returned to the lake.

Age and Growth Determination

Fish ages were determined by scale reading. Scales were cleaned by soaking in distilled water and rubbing between the finger and thumb, and were mounted in distilled water on slides. They were examined under a binocular microscope at x20 or x40 magnification, depending on the size of the scale and were measured with an eyepiece graticule. Scales were initially examined blind (i.e., without knowledge of the length of the fish from which they originated) and then examined with access to length data. When the two values did not agree, scales were re-examined and discarded if ambiguous.

Data obtained from the samples were used to construct length-weight relationships for the fish species sampled. Regressions of fish body-length on scale-radius were used in later analyses (back-calculation). Fish biomass (kg/ha) and growth rates were also calculated. Roach relative growth rates were determined using a standard index (Hickley & Dexter 1979). Predicted maximum roach length was calculated using a Walford Graph (Ricker 1975).

Fraser-Lee back-calculations (Equation 1) were carried out for all fish species sampled. Back-calculation uses measurements made on a fish at one time to infer its length at an earlier time or times. Measurements utilized are length of fish at time of capture and dimensions of one or more marks on some hard part of the fish. In this case hard parts were scales, marks measured being annual checks in growth that are recorded upon scales as annuli.

Equation 1: Fraser-Lee Back-calculation equation

$$L_i = c + (L_c - c)\left(\frac{S_i}{Sc}\right)$$

Where: L_i = *Fish length at time of* i^{th} *radius*
S_i = *Scale radius at time of* i^{th} *radius*
L_c = *Fish length at time of capture*
S_c = *Scale radius at time of capture*
c = *fish length at scale formation*

Results

The survey indicated that the fish population was of low species diversity and consisted of three species: roach *Rutilus rutilus* (Linnaeus, 1758), gudgeon *Gobio gobio* (Linnaeus, 1758) (Order Cypriniformes) and perch *Perca fluviatilis* Linnaeus, 1758 (Order Perciformes). Total fish numbers and biomass caught by seine within the lake are given in Table 1, together with estimates of species biomass/ha. These data indicate that the lake supports approximately 80 kg/ha of the three fish species combined. The roach population contributes the majority of this biomass (over 78 per cent).

Seine-netting showed that the roach population was composed of 1–6+ (year old) individuals with a length range of 69–151 mm. A Walford graph suggests that roach in the lake may reach a maximum size of approximately 200 mm (Figure 2). Comparison of length:age data with a standard curve constructed from national data (Hickley & Dexter 1979), shows that growth is close to average when the roach are in their first year, but decreases markedly with age giving a population average of 83.6, much lower than the standard of 100. This calculation is supported by data obtained by scale analyses, the roach showing low mean annual growth increments (Figure 3a). Back-calculation data also indicate that growth patterns have probably remained similar for at least the past four or five years with little variation shown in the year-class:length relationship (Table 2). Some individuals of less than one year were obtained whilst electro-fishing, indicating that the roach population had reproduced the previous spring. Analysis of stomach contents of six roach taken for autopsy demonstrated that the fish diet at that time consisted of silt, plant material, oligochaete worms, crustaceans and insects. One roach was heavily infected with ectoparasitic protists *Trichodina* sp. that had covered the gill filaments. The other five roach were uninfected by parasites.

Netting results indicated that the gudgeon population was composed of fish aged 0–4+, 40–142 mm, but comprised mainly juvenile fish. Out of a total of 25 individuals analysed for age, 18 were immatures of two years old or younger.

Their back-calculated growth rate, however, conformed with normal growth values suggested by Maitland & Campbell (1992) for the species. At the end of their first summer they had reached 46 mm, 100 mm by the end of their second year and 114 mm by the time they were three years old (Table 3, Figure 3b). Although the number of older fish caught by seine was low, many adult fish were seen shoaling at the base of the waterfall during the electro-fishing survey, suggesting under-representation in the net sample. As with roach, young-of-the-year gudgeon were obtained by electro-fishing, indicating that breeding had been successful in the previous spring.

Both electro-fishing and netting demonstrated that the frequency of perch within the lake was low, although those caught appeared to be in good condition and ranged from 2–5+ and 94–175 mm in length. An insufficient number of individuals were caught for reliable analyses of population age or size structure. These data suggested that the perch in the lake were attaining lengths close to those suggested as normal by Maitland & Campbell (1992). As in the other two species, a few young-of-the-year perch were obtained by electro-fishing, indicating that breeding had occurred in the previous spring.

TABLE 1.
Number and biomass of fish caught by seine in Buckingham Palace Garden lake on 5 May 1996

Fish Species	Number in seine	Biomass (kg)	Biomass (kg/ha)
Roach	150	2.27	63.07
Gudgeon	45	0.35	9.73
Perch	8	0.27	7.50
Total	203	23.34	80.30

Discussion

Data obtained from the survey indicate a lake with a low diversity and density of fish with low to normal growth rates. Most still waters will support coarse fish populations of 300–800 kg/ha (Cooper 1991) and therefore the population density estimate of some 80 kg/ha suggests that the lake is below estimates for an optimal environment for supporting fish.

TABLE 2. Back-calculated lengths of Buckingham Palace lake roach *R. rutilus* obtained from measurement of scale annuli.

	Roach length (mm) at age:															
Age	*n*	0	95%	1	95%	2	95%	3	95%	4	95%	5	95%	6	95%	7
1	3	41	17	62	8	*74*	*21*									
2	16	38	2	60	4	83	4	*97*	*2*							
3	6	37	7	61	8	80	9	98	10	*109*	*5*					
4	11	37	1	58	4	78	8	101	7	118	4	*125*	*4*			
2	38	31	63	89	83	111	34	127	54	137	104	*144*	*89*			
6	1	39	–	52	–	67	–	105	–	122	–	135	–	145	–	*150*
	mean	38	1	60	2	81	3	99	3	116	4	128	4	144	18	150
	n	39		39		39		36		20		14		3		1

n number of fish in sample 95% 95% confidence interval age fish age in years (birthday taken as 1 June)

length in *italics* are 'plus growth' i.e., growth increments derived from the measurement taken from the annulus to the edge of the scale representing the growth since the fish's last birthday.

TABLE 3. Back-calculated lengths of Buckingham Palace lake gudgeon *G. gobio* obtained from measurement of scale annuli.

	Gudgeon length (mm) at age:									
Age	*n*	0	95%	1	95%	2	95%	3	95%	4
0	16	47	3	*60*	*4*					
1	4	45	4	76	6	*107*	*8*			
2	5	44	11	73	10	96	10	*113*	*11*	
3	1	47	–	75	–	104	–	119	–	*132*
	mean	46	2	65	4	100	6	114	9	*132*
	n	25		26		10		6		1

n number of fish in sample 95% 95% confidence interval age fish age in years (birthday taken as 1 June)

length in *italics* are 'plus growth' i.e., growth increments derived from the measurement taken from the annulus to the edge of the scale representing the growth since the fish's last birthday.

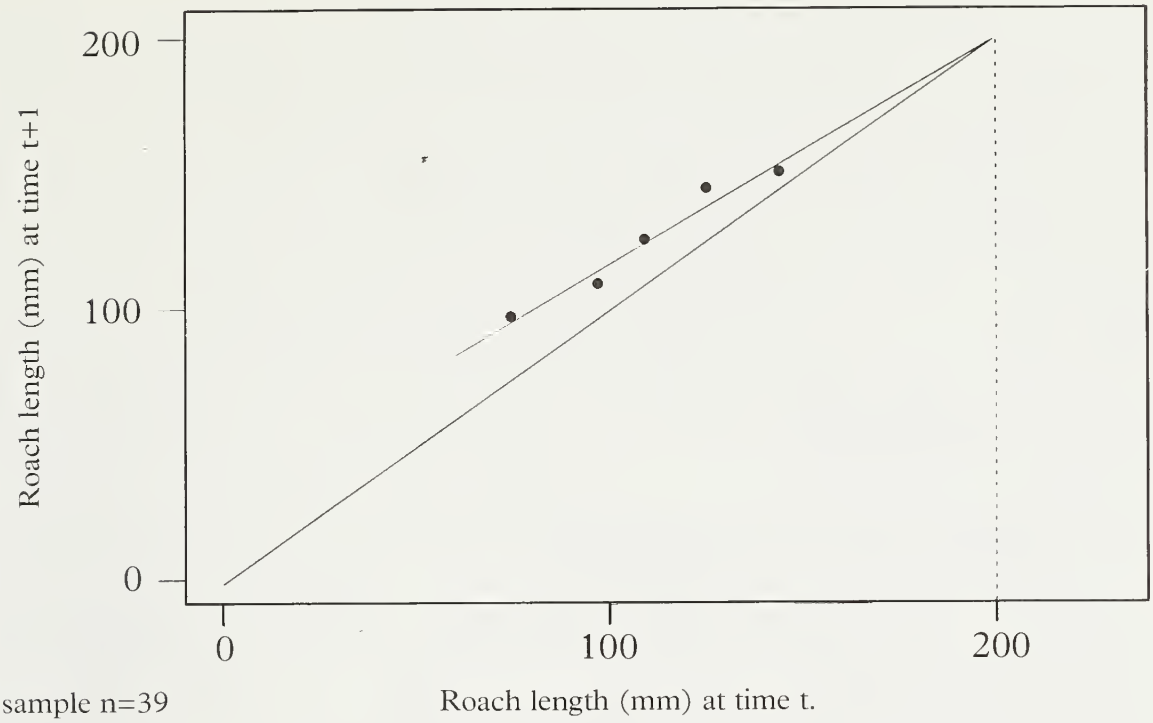

Figure 2:
Walford graph of Buckingham Palace Garden lake roach population.

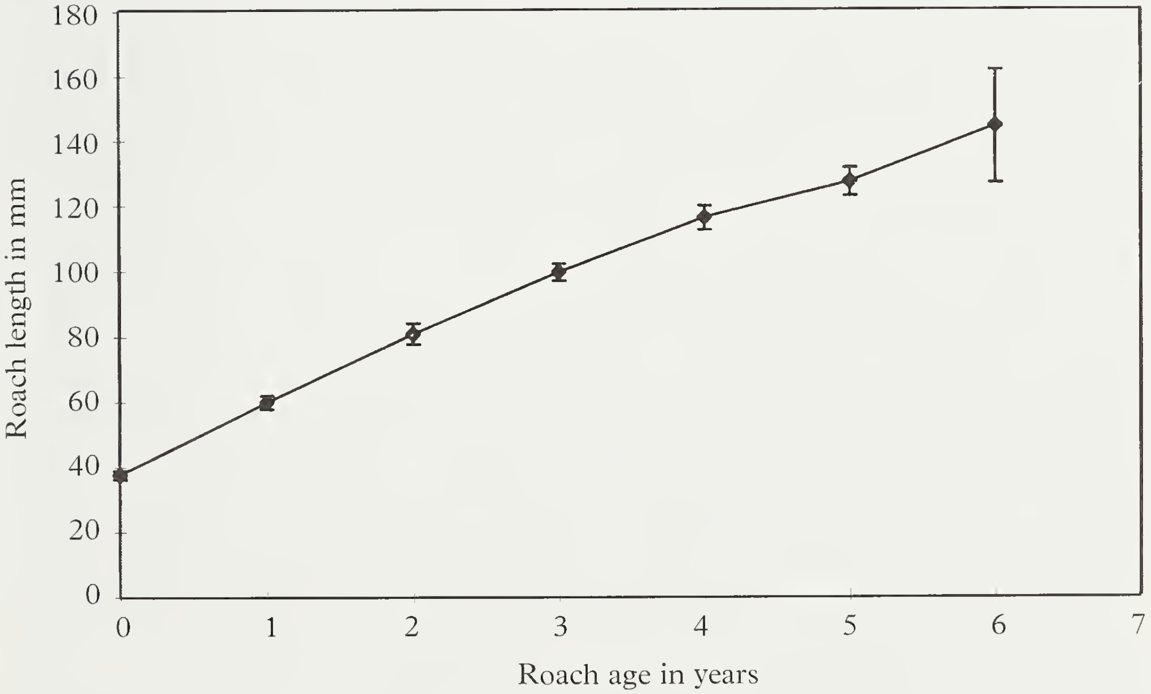

Figure 3a:
Growth curve for roach *R. rutilus* in Buckingham Palace Garden lake.
Mean lengths for each year class are shown ± 95% confidence intervals.

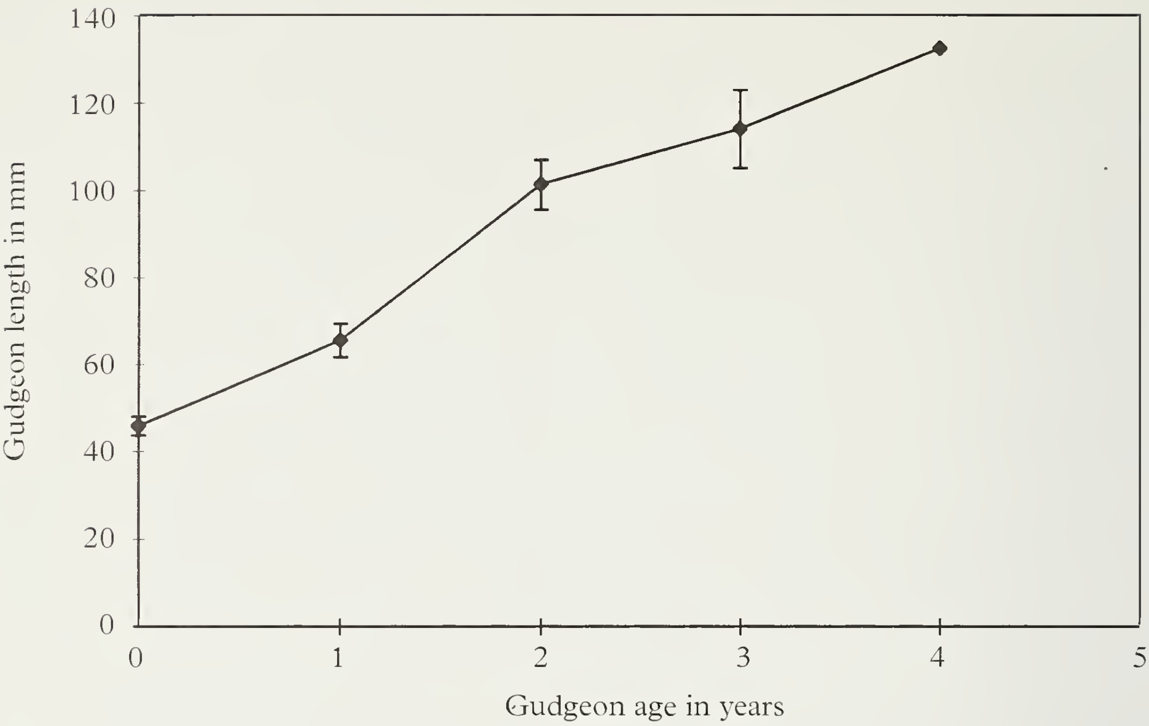

Figure 3b:
Growth curve for gudgeon *G. gobio* in Buckingham Palace Garden lake.
Mean lengths for each year class are shown ± 95% confidence intervals.

The roach is a common member of the carp family found in the majority of waterways of lowland Britain. It is tolerant of a wide range of environmental conditions and is thus found in many different aquatic habitats. It is essentially omnivorous in habit and the size of individuals within a population will be strongly dependent upon the nature and productivity of the environment. The roach in the lake are small in comparison to the length of roach in other habitats such as the River Thames, but not unusually so in comparison with other small, urban lakes (Kett, unpublished data). Comparison with Hickley and Dexter's index of roach growth shows that the roach in the lake grow well in their first year, but that growth rates decline as the fish approach adulthood.

Gudgeon are more usually associated with riverine habitats or gravel-bottomed lakes. Their streamlined shape enables them to maintain their position in running water. They are a small fish, rarely reaching more than 150 mm under optimum conditions. Their presence in the lake is unexpected, bearing in mind the high organic content of the benthic substrate. It is probable that their long-term survival in the lake has been assisted by the water recirculation system and particularly the waterfall where shoals of gudgeon were observed during the electro-fishing survey. Spawning usually takes place in shallow water, over gravel, but in the lake spawning probably occurs at the base of the waterfall where oxygenation levels are highest. The lake probably supplies sufficient benthic invertebrates to support good growth of this species. Their low overall biomass as part of the sample may be a result of under-representation in the seine. Their benthic habit and fusiform morphology mean they were the species most likely to escape the net by slipping underneath it during the haul.

Very few perch were found during the survey and this may reflect the turbid nature of the water within the lake. Perch are predatory fish, feeding on zooplankton in their first year and then macroinvertebrates until they are large enough to be capable of consuming prey such as juvenile fish of their own and other species. Perch are characteristic of slow and still waters where they ambush their prey from stands of vegetation or similar refugia. The low number of perch is probably a consequence of the eutrophic nature of Buckingham Palace Garden lake and interspecific competition with roach for prey. Persson (1987) has shown that roach outcompete perch when foraging for zooplankton, especially when both species are in their first year of growth. Interspecific competition with roach can force juvenile perch to switch to feeding on macroinvertebrates sooner than normal, leading to increased intraspecific competition with older year class conspecifics. Persson & Greenberg (1990) refer to this phenomenon as a 'juvenile bottleneck'. Relatively few perch under these conditions manage to reach a sufficient size to make the change from macroinvertebrates to fish as the main diet component. These factors, together with the lack of macrophytes required for spawning, are likely to have combined to limit successful recruitment within the perch population. This is not an uncommon situation in eutrophic lakes, indeed, Persson (1987) states that under such conditions it is usual for roach to be numerically dominant over coexisting perch.

The previous survey of the Garden reported that the lake supported a population of roach, gudgeon, perch and dace *Leuciscus leuciscus* (Linnaeus 1758) (Evans et al. 1964), but no evidence of the latter species was found by either method of survey. Although absence of evidence is not evidence of absence, the thoroughness of the survey precludes the likelihood of their continued presence in the lake. Dace are characteristic of running-water habitats and, although adaptable, are unlikely to maintain a self-sustaining population under present conditions. It is probable that the common origin of the four species found originally in the lake was the Serpentine, as suggested by Evans et al. (1964). The disappearance of the dace is likely to be due to the isolation of the lake and changes in the nature of the water.

Eutrophication may be a key factor in ordering the composition of fish populations in Buckingham Palace Garden lake. The lack of submerged macrophytes within the lake has already been mentioned, together with the concomitant paucity of macroinvertebrates. These factors, together with abundant waterfowl and the fish, contribute to the summer turbidity of the lake. In non-eutrophic lakes, macrophytes form the major habitat for rich faunas of macroinvertebrates and larger species of planktonic Crustacea, e.g., waterfleas, *Daphnia pulex* (De Geer). Such communities form major prey components of foraging fish (Hulsmann & Mehner 1997). However, dense macrophytes also constitute refugia for invertebrates against fish predation (Moss et al. 1998). Planktonic Crustacea, safe in macrophyte refugia, restrict phytoplankton population growth by filter-feeding (Stephen et al. 1998). Additionally, photosynthesizing macrophytes reduce dissolved plant nutrient concentrations and produce algicidal compounds inhibiting phytoplankton populations (Moss 1980).

These balanced, complex systems are vulnerable to perturbations, ultimately affecting the nature and status of lake fish populations. Such perturbations may have influenced the present state of the lake. Changes were probably gradual; accumulation of debris from surrounding terrestrial vegetation concentrated organic material in the lake as did constant addition of waterfowl faeces. Run-off from surrounding surfaces introduced organic and inorganic nutrients which accumulated in the sediments. Under these conditions, organic materials decomposed, releasing nutrients. Foraging waterfowl and fish disturbed benthic sediment, resuspending nutrients in the water column. Phytoplankton and filamentous algae bloomed, shading and blanketing submerged macrophytes which slowly died. Perch lost spawning substrate and ambush sites. Macroinvertebrates and large zooplankton were deprived of habitat and refuge from fish predation. These processes reduced predation pressure on phytoplankton and increased water turbidity. Further up the food chain, the fish community were affected in other ways. Juveniles grew more slowly as a result of the prevalence of smaller zooplankton species. This increased both competition for, and predation pressure on, the zooplankton community.

The processes operating within Buckingham Palace Garden lake have kept it in a eutrophic state and reduced the diversity, growth and abundance of the fish community. The loss of the dace population was very likely a result of these processes. Eutrophication decreased their foraging efficiency and availability of suitable spawning substrate. Perch are, however, more characteristic of still waters than dace and were probably less disadvantaged by the eutrophication. They persist within the lake, albeit at a low population density, where the dace have, apparently, become extinct. Roach, however, are less disadvantaged under such conditions. They are able to outcompete perch under conditions of eutrophication, being more effective filter feeders on zooplankton and able to subsist, if poorly, on phytoplankton and detritus (Persson 1983). Roach are also more eclectic in spawning substrate, utilising, in the absence of other substrates, tree roots or even stones (Holcik & Hruska 1965). Deprived of weedbeds within which to forage and facing competition from perch for macroinvertebrates and zooplankton, the Palace lake roach increasingly fed by processing benthic silt for the macroinvertebrates living within it. Disturbed silt is soft and flocculant and a poor substrate for macrophyte roots. Badly anchored, shaded and outcompeted by algae, macrophytes were easily uprooted by foraging fish. Of all the fish species within Buckingham Palace lake, roach are hardiest, capable of surviving elevated water temperatures and low levels of dissolved oxygen. The lake is rich in decomposing organic material and exists in the midst of a metropolitan heat island. Oxygen levels are likely to fall in very hot summers, giving roach a vital competitive edge, permitting their domination of the fish community. Perch, gudgeon and dace, and especially their spawn, all require lower temperatures and higher dissolved oxygen levels to thrive.

Such small populations are most vulnerable to random fluctuation in numbers (Williamson 1989). Perch, low in number, outcompeted by roach and short of spawning substrate are the next most likely candidates for extinction under present conditions. The isolation of Buckingham Palace Garden precludes likelihood of natural recolonization, but anthropogenic influence could work to counter the processes that are presently causing deterioration of the lake fish population.

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Amphibians and reptiles in Buckingham Palace Garden

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Abstract

A record of the common frog *Rana temporaria* in Buckingham Palace Garden is given. There are old records of both frogs and the common toad *Bufo bufo* in the Garden, but no other amphibian species and no reptiles have ever been reported here.

Amphibians

The only amphibian noted during the 1995-97 survey of Buckingham Palace Garden would appear to be the common frog *Rana temporaria.*

Frogs have been seen intermittently in the Garden over the past thirty years, though always on land (Mark Lane, pers. comm.). Knight (1964) reported that frogs were very rare in the Garden and listed only a single female found in 1953, adding that no one had ever seen tadpoles or spawn in The Lake. During the 1995-97 survey, single adult frogs were seen on two occasions only, in long grass near The Stoneyard and in grass adjacent to the Back Path, both in the autumn.

The presence of frogs in central London is not a surprise. Langton (1991) remarked that 'In much of urban London you are probably never more than tens of metres from the nearest common frog, making it one of the commonest terrestrial vertebrates and possibly ...... numerically one of the most abundant'. His distribution maps show that the frog was then present throughout much of the urban area of London.

It is difficult to know how Buckingham Palace Garden could sustain a viable breeding population of frogs. The only water where breeding is possible is in The Lake and this is largely devoid of submerged water plants, heavily eutrophic and has a population of predatory fish. No tadpoles have ever been encountered during pond netting or electro-fishing operations and no spawn has ever been seen. Surely the number of frogs seen would be considerably higher if they were breeding here? It is equally hard to believe that a frog migrating back to its natal area might cross one of the busy main roads that surround the Palace and then scale the boundary wall to get to The Lake. Adult frogs live for several years. Langton (pers. comm.) suggests that six years is a good age for a frog though survival to the early teens is possible. Earlier, Burton (1968) suggested that twelve years, in a captive animal, was the record. The notion of a few survivors from an earlier period is possible, though unlikely.

A more interesting possibility is migration of frogs to the Garden via subterranean pipes. The recent report to the London Natural History Society's recorder for amphibians of a frog in an entirely enclosed back yard cesspit in the centre of Soho, gives strong evidence that the animal arrived there via an old, underground sewer, possibly from the Hyde Park area (Langton, pers. comm.). The possibility that frogs gain access to Buckingham Palace Garden by similar means is not one which can be overlooked. It is also quite possible that small frogs could be imported with potted plants or other items on an occasional basis.

The common toad *Bufo bufo*, appears to have been reported once only. Knight (1964) states that one was discovered under a large rock when the cascade was being built. There does not seem to be any other record and The Lake is judged to be entirely unsuitable as a toad breeding site today.

Reptiles

No reptiles of any species were seen during the years 1995 to 1999 in the Garden.

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Birds in Buckingham Palace Garden

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Abstract

Birds were surveyed in Buckingham Palace Garden from January 1995 to December 1998, though the majority of observations were made in the first three of these years. A total of fifty-eight species was recorded, of which thirty were shown to nest in the Garden at least once during the survey period. A further ten species were free-flying visitors from the wildfowl collection in adjacent St James's Park. A census of breeding species was carried out for the three years 1995 to 1997 and the results are compared with an earlier census from 1961 to 1963. Three species breeding in that earlier period were not found in the Garden during the present survey, whilst eight species that were not recorded in the earlier work were found nesting this time. Possible reasons for the changes are discussed and comparisons drawn between the birds in Buckingham Palace Garden and those in the adjacent Royal Parks.

Introduction and methods

The birds in Buckingham Palace Garden were surveyed on a monthly basis throughout the period 1995 to 1997, with many additional visits made during the nesting seasons. Visits were generally of two-hour duration, but the results were very much dependent on weather conditions, with a certain amount of luck necessary for the observer to gain a few extra species during periods of migration. The winters of 1995–1997 were mild in comparison with those of the 1961–1963 survey and there were no significant hard-weather movements of birds across London. This may explain why some relatively widespread wintering species are absent from the list of birds seen in the Garden.

During the nesting seasons, a Common Birds Census was carried out, to criteria set by the British Trust for Ornithology (Marchant 1983). It was possible to compare the result of the breeding season censuses for 1995–1997 in the Garden with the previous census in 1961–1963 (Cramp and Spencer 1963). It was also possible to compare the results with similar census work carried out in the Inner London* Royal Parks. This produced not only a list of the species nesting, but also an estimate of the densities of breeding birds at each of the locations. The year 1996 was chosen because comparable data were available for all of the parks for that year.

Although the list of species nesting in the Garden has increased over the last 30 years, the overall number of birds present in the breeding season has declined by more than 20 per cent. These findings correlate with comparable survey work in the Royal Parks (Nicholson 1995, Green 1999), and bear disturbing similarities with decreases in bird numbers elsewhere, blamed variously on changing farm practices, pesticides and increases in predators.

Management of the Garden has been extremely beneficial for the birds, with sensitivity by all concerned for the needs of the wildlife.

Systematic list of observations

The majority of these records are for the years 1995 to 1997, when the main fieldwork was carried out, but a few later sightings have also been included. Where appropriate, references have been made to the status of some species in London in order to place the Garden records into context.

Whilst most of the emphasis of the survey was applied to the nesting season, the systematic list covers the whole year and includes birds that wintered in the Garden and also those that passed through here on migration. In the latter category were a few summer visitors rarely seen in Inner London: Turtle Dove, Sedge Warbler, Lesser Whitethroat and Common Sandpiper.

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*The term 'Inner London' as used here with initial capitals, is that first defined by A. Holte MacPherson in 1929 (see Plant, 1987: 7 for details).

Uncommon wintering birds were confined to the lake where Smew and Goosander were seen. Fieldfare and Redwing were absent because the survey was carried out during a succession of mild winters. These species are more usually seen in London when there is prolonged frost or lying snow in the surrounding countryside.

Little Grebe
One on 22 March 1995 and from 7 to 10 March 1996. The last breeding record for the Garden was in 1949. These quite shy birds require a fair amount of nesting cover and are intermittent breeders in Inner London. A pair last bred successfully in St James's Park in 1988 and in Regent's Park in 1994. One or two birds are seen in most years on The Long Water in Kensington Gardens, but there are no breeding records this century.

Great Crested Grebe
A pair nested successfully under an overhanging willow on the small island each year. There were two broods in 1995 and 1997 and all the young fledged. The first successful breeding records for Inner London were in Kensington Gardens and Regent's Park in 1972, where pairs have since nested annually.

Cormorant
Two on 24 April and one on 13 September 1995; singles on 24 April, 12 May and 15 December 1996; singles on several dates in January, April, May and December 1997. Cormorants became regular visitors to The Serpentine in Hyde Park from 1974 and there is now a substantial breeding colony in the Lea Valley in eastern London, where nesting first took place in 1987.

Grey Heron
One was seen in every month during the period of the Garden survey, with two present on 7 April 1997. The species has been seen regularly in Kensington Gardens since 1969. The nearest breeding colonies are in Regent's Park (established in 1968) and Battersea Park (from 1990).

Mute Swan
A pair nested on the main island in 1997 but the birds were continually harassed by Carrion Crows. Eventually they were removed for their own protection to a swan sanctuary. Ring numbers on the swans showed that they had come together in 1996, one from Horley, Surrey, the other from the Thames at Hampton, and they bred successfully in Hyde Park in 1996 before moving to Buckingham Palace Garden on the 17 March 1997.

Greylag Goose
Twenty-six young hatched in 1995 and six in 1997, with nests in the thickest shrubberies. Geese fly in on most days to graze on the main lawn, the largest count being 73 on the 2 December 1996. They are part of a growing population that fly between St James's Park and Hyde Park for much of the year, some dispersing elsewhere to nest. They originate from the wild progeny of naturalized birds, similar to the large flocks now in Kent and other counties. Total numbers in Inner London now exceed 200 birds.

Canada Goose
Nesting took place each year but no young were hatched. As with Greylags, Canada Geese fly in daily to graze on the main lawn, the largest count was 59 on the 16 January 1995. They derive from introductions nearly forty years ago in the Inner London Royal Parks and from naturalized birds from other parts of the London Area.

Mallard
Bred in all three years, with up to ten broods each year. Maxima were 47 birds on 22 February1995; 36 on 8 February 1996; 43 on 20 December 1997, rising to an amazing 94 on 14 January 1998. Botulism accounted for 25 deaths in 1995, when the same bacterium was also prevalent in The Long Water in Kensington Gardens. As there is no expectation of being fed, the tameness of the ducks, so apparent in the Royal Parks, is certainly not shown in the Garden, where they are all quite shy, seldom allowing a close approach.

Shoveler
On the lake between October and March: in 1995 up to three: in 1996 up to 12, and in 1997 up to 14 birds. One in June and July 1995 was probably from the St James's Park collection.

Pochard
There has been a resident population of Pochard in the London Area for some forty years. Migrants from eastern and northern Europe join these in winter. The largest numbers in the Garden were seen between November and March, with 14 on the 18 February 1996. Three were present throughout the summer of 1996, but no nesting was proved. A pinioned pair was released in March 1997. Nestboxes were placed on the island in February 1998.

Tufted Duck
Present throughout the year, the highest count was twenty-four on the 11 March 1996. Breeding took place each year with six broods totalling 34 young, but largely owing to lack of cover, predation was high. A pinioned pair was released in March 1997.

Smew
A female or immature bird was on the lake on 14 January 1998.

Goosander
Two ducks on 21 January 1996. They left when the lake froze over, but four were there on 6 February, with two staying until 11 March. In the following winter one was present from 6 to 12 February and a pair from 7 to 10 March 1997. A drake was seen on 14 January 1998. This is a rare species for Inner London.

Ruddy Duck
One from 1 to 10 June 1996. This seems likely to have been a wild bird as none is kept in the St James's Park collection. This naturalized species breeds regularly at Brent Reservoir and other sites in London including Regent's Park.

Sparrowhawk
During the three years of the survey, a pair of Sparrowhawks nested in a private garden just to the west of Kensington Palace. This resulted in many sightings in the Garden throughout 1996 and 1997, including one of a bird killing a young Woodpigeon in July 1996.

Kestrel
This species has recently become much less common in Inner London, with some of the previously regular nest sites no longer occupied. In the Garden, one was seen occasionally up to June 1995, with three sightings in 1996 and two in 1997.

Moorhen
Two or three pairs nested each year. Up to seventeen birds were present during the autumn and winter months. A list of birds in Buckingham Palace Garden in 1872 showed 30 or 40 Moorhens were present.

Coot
Three or four pairs nested each year. Present throughout the year with the largest counts in March and April, up to 16 in 1996, with fewer birds in the autumn.

Common Sandpiper
A passage bird was noted on 13 August 1997.

Black-headed Gull
Almost all sightings have been of birds flying over the Garden. There are several hundreds in the Inner London parks between September and March, attracted by the ample food supplied by visitors. Movements to and from roosts take place over the Garden each day during that period.

Lesser Black-backed Gull
One over the Garden on 22 March 1995 and on the lake on 21 July 1995. One or two fly over throughout the year, and they are regularly seen on The Serpentine.

Herring Gull
One or two visited the lake area between April and July and they were also seen flying over the Garden throughout the year. Some pairs nest on buildings in north London and around Regent's Park. The Herring Gull is a main predator of ducklings in the Inner London parks.

Common Tern
Two passage birds flew over the Garden on 17 May 1997.

Feral Rock Dove
The feral pigeon of London and other city centres derives from birds which escaped from dovecotes in historic times. These birds are attracted to the parks and squares for food handed out by visitors. In the Garden they are occasionally seen feeding among the grasses near the tennis courts. Up to seven were seen in 1997. Large numbers are in St James's Park all year round and nest on buildings in or near the Garden.

Stock Dove
Two on 18 June 1995 and one on 18 August 1996. A pair was seen displaying for much of April and May 1997 high in plane trees where they may well have nested. This quite secretive species nests regularly in Kensington Gardens.

Woodpigeon
A difficult species to count accurately as they fly around the Garden and in and out of Green Park. Twenty to thirty individuals are probably resident in the Garden. Adults were seen on ten nests in 1996, although which were successful is not known. Young birds that had almost certainly hatched in the Garden were seen in all years.

Turtle Dove
A passage bird was seen on 1 June 1996.

Tawny Owl
All records of sightings are from gardeners and the police. Birds have been heard calling at night and there was one record of an owl on the lawn. In 1997 a nest with eggs was found in a plane tree just outside the wall at Hyde Park Corner. As the branches of the tree, at the time, overhung the Garden, it has been counted as a nesting species for 1997.

Swift
A few can sometimes be seen feeding high over the Garden between June and August. The nearest nest sites are probably on larger, older houses in the Bayswater and Holland Park area.

Kingfisher
One was watched fishing on the lake on 17 June 1998, quite a rare sight in central London. The bird was seen adjacent to an artificial Kingfisher 'bank' or nest site put in place some years ago. A gardener reported a second sighting on 5 August 1998.

Green Woodpecker
In 1997 a pair nested in Kensington Gardens for the very first time. This led to several sightings in Hyde Park and St James's Park. There was one in the Garden on several occasions with five sightings between 27 July and 15 October 1997, and more records into 1998.

Great Spotted Woodpecker
Several observations in 1996 between 21 April and 13 October with drumming heard during the nesting season. There were fewer sightings in 1997, but two were seen on 17 May. At least one bird was in the Garden from April to June 1998. The species began to nest regularly in Hyde Park and Kensington Gardens in 1995.

House Martin
Although House Martins (and Swallows too) migrate across London there were only two sightings during the survey, both of House Martins. Six were over the Garden on the 8 October 1995 and two more on 18 August 1996. The nearest nesting colony of House Martins is under the eaves of the French Embassy and the adjoining building by Albert Gate in Hyde Park. The first Inner London nesting was in 1966, but the species is now in decline.

Grey Wagtail
One seen around the lake on 2 and 9 June in 1995 and 10 and 11 May, 24 June and 17 September in 1997. In 1995 a pair nested at Blackfriars and another pair possibly bred near Regent's Park. Inner London records are rather unpredictable, with most reports being outside the breeding season. Only one to three pairs nest each year in Inner London.

Pied Wagtail
This species was listed among those nesting during the 1961 to 1963 survey of the Garden. Most records this time were of single birds on 25 May 1995 and 7 April, 16 May and 19 June 1997, insufficient to suggest any nesting birds in the vicinity of the Garden. There was an interesting count of 15 birds on 13 September 1995, probably on their way to a nearby roost. An estimated six pairs nest in Inner London but their habit of nesting on buildings may mean several pairs go unreported.

Wren
This is one of the few species to have shown an apparent increase in numbers since the 1961 to 1963 survey. Using the Common Birds Census method, the number of Wren territories was estimated at four in 1995, six or seven in 1996 and five or six in 1997. This compares with only two or three pairs in 1961–62, with probably none nesting in 1963. The Wren is a species very susceptible to harsh weather conditions, a reason put forward for the 1963 failure. Wrens are in the Garden throughout the year.

Dunnock
One or two pairs nested each year, sharply down from five to eight pairs that nested in 1961–62. A similar reduction was noted during census work in Hyde Park and Kensington Gardens, this apparently happening during the 1980s. Birds were seen in the Garden throughout the year, favouring the shrubberies near the eastern end of the mound.

Robin
Between four and eight pairs nested during the survey period, compared with between three and five pairs last time. This increase is in line with similar findings in the Hyde Park and Kensington Gardens censuses. There was a nest with five young in a greenhouse in 1995. Present throughout the year.

Blackbird
Eight to twelve pairs nested each year, slightly lower than in the last survey. These numbers are close to the highest possible for the Garden for this territorial species. Blackbirds can be seen throughout the year in the Garden, but there are fewer in winter.

Song Thrush
The 1961–1963 survey estimated that between five and ten pairs were nesting in the Garden. In 1995, no nesting was proved, with only one or two pairs nesting in 1996 and 1997. This huge reduction reflects the concern nationwide, with the Song Thrush having been placed on a list of endangered species by the Royal Society for the Protection of Birds, and with studies under way to try and establish reasons for the decline in numbers. Outside the breeding season single birds were seen in October 1996 and October 1997.

Mistle Thrush
One or two pairs nested in 1996; one nest was in a Lombardy poplar. The Garden was part of a territory in 1995 and 1997, with the birds flying between the main lawns in the Garden and Green Park. No change in status since the last survey. Birds were present throughout the year.

Sedge Warbler
One was singing in a willow on the island on 1 June 1996.

Lesser Whitethroat
One was seen on 12 May 1996.

Blackcap
One on 24 April 1995. One was singing on 18 June 1995 and 7 June 1997. A male was present in the Garden near the mound from April to June 1998, almost constituting a territory. It was disappointing not to find this species nesting in the Garden. Two or three pairs nest in Hyde Park and Kensington Gardens each year and a pair nested in St James's Park in 1996.

Chiffchaff
Passage birds were noted in 1995 on 24 April, 13 September and 8 October. In 1996 they were recorded on 24 April and in 1997 between 11 and 17 March.

Willow Warbler
One was seen on 13 August 1997.

Goldcrest
Up to two were seen among mixed tit flocks between 16 August and 12 November 1995. One was noted on 13 October 1996, and two on 15 December

1996. In 1997 there was a spring record on 17 March and up to three in the autumn from 6 November to the end of the year. This species first nested in Inner London in 1971. Two pairs nested in Regent's Park in each of the years 1996 to 1998.

Long-tailed Tit
One pair bred each year, favouring the herbaceous border on the north side of the Garden. Outside the nesting season the species tends to feed in small flocks, the largest counts being 18 on 10 September 1996, and 20 on 20 December 1997. This species first nested in Inner London in 1972 and now nests in most of the Royal Parks.

Coal Tit
A pair was seen in 1995, but no nesting proved. The following year, two pairs bred and in 1997 there were two, or possibly three, pairs breeding. The Coal Tit was not nesting in any of the Inner London parks at the time of the 1961 to 1963 survey, but began nesting regularly in Hyde Park and Kensington Gardens in 1966. One or two pairs now also nest regularly in St James's Park. One or two birds can be found in mixed tit flocks at other times.

Blue Tit
A difficult species to census accurately, but up to eleven pairs may have nested in 1996, with perhaps six or seven pairs in 1997. Blue Tits form the largest component of the mixed tit flocks in the Garden during the autumn and winter. A few nest boxes were erected in the Garden in 1998 and were in use the following year.

Great Tit
Between two and four pairs nested each year. One pair used a nestbox and another favoured a lamp-post. Ten recently fledged young were seen on 7 June 1997. Birds are present throughout the year.

Treecreeper
There were four sightings between 8 March and 10 June 1996. One or two pairs now nest regularly in Hyde Park and Kensington Gardens.

Jay
A pair was present throughout the 1996 and 1997 breeding seasons and were apparently carrying food in April 1997. One or two were seen in the Garden regularly through to October 1997 and again in June and July 1998.

Magpie
There were two nests in the Garden each year, with a third nest that may also have been used in 1996. A parliament of 14 was observed in the Garden on 11 March 1996. London was the last major city in the country to be colonized by Magpies and this was in 1971, when pairs bred in Regent's Park and Kensington Gardens for the first time this century.

Carrion Crow
Two or three pairs nested each year. These birds no doubt prey upon the ducklings round the lake and gave the Swans a hard time when they attempted to nest in 1997. Groups of 50 or more have been present in Kensington Gardens since the mid 1960s. In the Garden, an estimate approaching 200 crows in the trees was given to me by one of the Garden staff during 1997. Counts in excess of 30 were seen throughout the study period, with birds flying across to join others in Green Park, open parkland ideally suited to crows.

Starling
One or two pairs nested, with adults seen taking food up into the Palace building. No nests were found in the Garden with few large old trees, other than planes, to provide nesting holes. There has been a dramatic decline in the wintering Starling population in London since the last survey and large roosts of many thousands around Trafalgar Square are now only a memory. Starlings were seen in the Garden only during May and June, with a maximum of 20, apart from two birds in September 1997.

House Sparrow
In 1961–62, an estimate was made of between ten and twenty pairs nesting. During 1995–97, there were only occasional sightings of one or two birds, with no evidence of nesting. The decline of the House Sparrow in London has been documented in regular counts in Kensington Gardens (Nicholson 1995). It is not a new phenomenon, but probably started in the 1940s, although the pace of the decline has quickened recently. There are now only two pairs nesting in St James's Park, where sparrows no longer congregate for a share of visitors' picnics.

Greenfinch
One pair nested in 1996, with recently fledged young seen on 10 June. The only other record was one on the 8 October 1995. Between 10 and 18 pairs nested in the 1961 to 1963 survey. The reduction in breeding numbers has also been observed in Hyde Park and Kensington Gardens and other London parks.

Species of captive origin

In recent years the wildfowl collection in St James's Park has been managed differently. A decision was made about the carrying-capacity of the lake, in terms of numbers of ducks and geese species. To prevent over-capacity, the young of endemic species that are hatched each year are no longer pinioned. This has led to a wide range of wildfowl flying around the lakes of Inner London, often at a time when the truly wild birds would not be seen in London. The following records refer to sightings in Buckingham Palace Garden of birds that originated from the collection in St James's Park.

Bar-headed Goose
One was seen in June 1996.

Barnacle Goose
Up to four were seen every month except July and August, usually grazing with Canada Geese.

Shelduck
Up to seven were seen in 1995, but more usually up to four are present in most months. A pair bred in the Garden in 1996, only three of the nine ducklings survived, the others being eaten by Carrion Crows as they crossed the lawn in an abortive attempt to get to St James's Park. The survivors were taken to St James's Park lake after the adults deserted them.

Ruddy Shelduck
A free-flying bird from St James's Park occasionally joins three pairs of pinioned birds.

Mandarin
A pinioned pair was presented by The Wildfowl & Wetlands Trust in 1997. Palace staff in the Garden reported two free-flying birds in May 1996 which may have been wild. Mandarins now breed in at least eleven sites in the London Area.

Wigeon
Two were seen on 1 June 1996 and one on 15 October 1997.

Chiloe Wigeon
Single birds were noted in June 1996 and in May and June in 1997.

Gadwall
Two observed on 10 May and one on 17 May 1997.

Teal
Two were present from 12 to 19 February 1997.

Pintail
Up to eight were seen each year between January and May.

Pinioned birds

A collection of six pinioned Red-breasted Geese was reduced to one by an urban fox that found a way into the Garden during the autumn of 1995. Later, on 26 January 1996, a fox also killed all eight Flamingoes in The Queen's collection. The Garden has since been made, hopefully, fox-proof! It was decided not to replace the Flamingoes, instead The Wildfowl & Wetland Trust presented Her Majesty with two pairs each of Red-Breasted and Emperor Geese, together with some pinioned ducks in March 1997. More pinioned birds were purchased in 1998 and at the end of that year the collection consisted of five Red-Breasted Geese, two Mandarin Ducks, six Emperor Geese, two Tufted Ducks, six Ruddy Shelducks and two Pochards.

Comparisons with the 1961 to 1963 survey

In the 1995 to 1997 survey, a total of 58 species was observed in the Garden (discounting collection species), compared with a total of sixty species observed in the 1961 to 1963 survey.

Notable differences between the surveys were the absence from the later work of wintering Redwing and Skylark and fewer passage species such as Cuckoo, Swallow, Sand martin, Wheatear, Whitethroat, Pied Flycatcher and Garden warbler, which were all seen in the 1961–63 period. It is thought that the present species list might have been increased had more early morning visits been made to the Garden during spring and autumn migration months.

The increase in species in the 1995–97 survey is mainly accounted for in an increase in nesting species.

Nesting species 1995–97

Some thirty species were recorded nesting in Buckingham Palace Garden during the 1995 - 1997 survey. These are listed in Tabie 1, which also shows the number of breeding pairs and gives comparative figures for the 1961 to 1963 survey.

The estimates for the number of song birds present during the nesting season were achieved through a Common Birds Census (Marchant 1983). During each visit, between March and July, the observer mapped all singing birds. Additional records of bird behaviour, such as birds carrying nesting material or food were also mapped. At the end of the breeding season the maps for each visit were analysed and conclusions drawn about the sizes and numbers of territories held by each species. Visits for a census of this kind are best in the early morning and evening when most birdsong can be heard. For the Garden, weekends are preferable when there is much less traffic noise.

Inevitably, territories for some species were quite large and only partly within the Garden. Mistle Thrush is an example of that, with some birdsong and feeding taking place across the wall in Green Park. By contrast, Wren and Robin territories were compact, with several pairs nudging together along the herbaceous border and male birds singing strongly to defend their territory from neighbours.

Similar censuses have been carried out in Hyde Park and Kensington Gardens. First over a 14-year period from 1967 to 1980 and more recently between 1994 and 1997. These censuses give a useful comparison with Buckingham Palace Garden and confirm that the fall in numbers of birds nesting is not confined to the Garden.

TABLE 1. Breeding bird species in Buckingham Palace Garden: estimates of the number of breeding pairs or birds holding territory for the years shown.

Species	**Year**				
	1961	**1962**	**1995**	**1996**	**1997**
Great Crested Grebe	—	—	1	1	1
Mute Swan	—	—	—	—	1
Greylag Goose	—	—	6	4-6	6
Canada Goose	1	1	6	4	4
Mallard	20-25	25-30	10	5	5-6
Pochard	1	1	—	1	—
Tufted Duck	10-12	10-14	2	3	6
Moorhen	4-5	5-8	3	2-3	2-3
Coot	4	4	3	4	3
Stock Dove	—	—	—	—	1
Woodpigeon	20-25	20-30	6-8	8-10	5-8
Tawny Owl	1	—	1	—	1
Great Spotted Woodpecker	—	—	—	1	—
(Pied Wagtail)	2	2	—	—	—
Wren	2-3	2-3	4-5	6-7	5-6
Dunnock	5-7	5-8	1-2	1-2	1-2
Robin	4-5	3-4	4-5	7-8	5
Blackbird	10-15	10-15	8-9	12	8-9
Song Thrush	8-10	5-6	—	1-2	1
Mistle Thrush	1	1	1	1-2	1
(Spotted Flycatcher)	2	2	—	—	—
Long-tailed Tit	—	—	1	1	1
Coal Tit	—	—	1	2	2-3
Blue Tit	3-4	4-6	4-6	10-11	6-8
Great Tit	2-3	2-3	2	3-4	2-3
Jay	1	1	—	1	1
Magpie	—	—	2	2-3	2
Carrion Crow	1	1	2	2	2-3
Starling	7-9	8-10	—	1-2	1
House Sparrow	5-10	5-10	1	1	1
(Chaffinch)	2	1-2	—	—	—
Greenfinch	5-7	7-9	—	—	—
Feral Rock Dove	—	—	1-2	1-2	1-2
Estimated total pairs	121-156	125-171	70-79	86-101	75-89
Number of species present each year	25	25	22	27	27
Total number of species	25			30	

Comparisons with 1961–63 breeding bird data

Compared with the previous survey in 1961–63 there have been eight additions and three deletions from the twenty-five species that nested then. These are summarized in Table 2.

TABLE 2. Gains and losses in breeding birds at Buckingham Palace Garden between the two surveys.

Gains	Losses
Mute Swan	Pied Wagtail
Great Crested Grebe	Spotted Flycatcher
Greylag Goose	Chaffinch
Great Spotted Woodpecker	
Stock Dove	
Long-tailed Tit	
Coal Tit	
Magpie	

The changes are remarkably similar to what has been observed in the Royal Parks over the same period. In fact only two species, Chaffinch and Blackcap, now breed in the Royal Parks but not in Buckingham Palace Garden. One other species, the Spotted Flycatcher, no longer nests in the Garden and has similarly been lost as a breeding species in Regent's Park and Kensington Gardens, with just one pair nesting in Hyde Park in 1998. The comparative densities of the breeding populations in the two surveys are shown in Table 1.

The top ten species for the two surveys arrived at by averaging the annual estimates of breeding pairs are shown in Table 3. Only four of the most numerous species in the 1961 to 1963 survey are still on the list today: Mallard, Woodpigeon, Blackbird and Tufted Duck. With the exception of Moorhen, the remaining species on the 1961-62 list were represented by only one or two pairs in the 1995 to 1997 survey.

The Starling count was down from between seven and ten pairs in 1961–62, House Sparrow and Song Thrush down from between five and ten pairs, Greenfinch down from between five and nine pairs and Dunnock down from between five and eight pairs. Overall the number of birds nesting in the Garden was down from between 121 and 171 pairs in the 1960s to between 75 and 101 pairs in the 1990s. This represents a significant reduction in the density of the breeding population over the last thirty years.

TABLE 3. The 'top ten' breeding species, presented in decreasing numerical frequency, at Buckingham Palace Garden.

1961 to 1962 Survey	1995 to 1997 Survey
Mallard	Blackbird
Woodpigeon	Woodpigeon
Blackbird	Blue Tit
Tufted Duck	Mallard
Starling	Robin
House Sparrow	Greylag Goose
Song Thrush	Wren
Greenfinch	Canada Goose
Dunnock	Tufted Duck
Moorhen	Coot

Comparison with Inner London Royal Parks

At the time of the 1961 to 1963 survey, estimates of the breeding population of birds in the Royal Parks were only available for Regent's Park (Wallace 1961). By comparing the estimates of breeding birds for the Garden and Regent's Park, the conclusion is reached that the density of breeding birds in the Garden was more than three times higher than for Regent's Park and Primrose Hill. Those densities were arrived at using total acreage for the Park and Garden, assuming that both had an almost equal proportion of open grassland unsuitable for nesting sites. Freedom from disturbance was thought to be the most important factor determining the higher density of breeding birds in the Garden. In 1961–62 the densities found for the Garden and Regent's Park were between 61–88 birds per ten acres and 19-22 birds per ten acres respectively. Expressed using the metric system, this equates to:

Density in Buckingham Palace Garden —1961–62	15-21 birds per hectare
Density in Regent's Park — 1959	5 birds per hectare

Using 1996 data for nesting birds, the revised densities for the Garden and Regent's Park are:

Buckingham Palace Garden	11–12 birds per hectare
Regent's Park	4 birds per hectare (Green 1997)

Both areas show a reduction in excess of 20 per cent in bird densities over the last thirty years, but the higher density of birds in the Garden remains at around three times that of Regent's Park.

The survey report for Buckingham Palace Garden for 1961–63 also referred to birds breeding in the Inner London Royal Parks at that time. Comparing that list with the species breeding in the parks in 1996, it is apparent that the changes since the 1960s are remarkably similar to those which have occurred in the Buckingham Palace Garden over the same period.

The following species, added to the breeding bird list in the Garden since the 1961 to 1963 survey, were also added as new breeding species to some of the Royal Parks:

Mute Swan (all parks)
Great Crested Grebe (all parks except St James's Park)
Greylag Goose (all parks)
Great Spotted Woodpecker (all parks except St James's Park)
Stock Dove (Kensington Gardens and Regent's Park)
Long-Tailed Tit (all parks)
Coal Tit (all parks)
Magpie (all parks)

Other changes since the early 1960s are not yet reflected in the Garden list. Blackcap, for example, now nests regularly in St James's Park and Regent's Park and might reasonably be expected to do so at Buckingham Palace Garden. House Martins moved into a cleaner Inner London in 1966 and now nest on the French Embassy at Albert Gate (Hyde Park). The eaves of Buckingham Palace would surely make an excellent nesting site!

Three birds were lost as breeding species for the Garden. The Chaffinch was a probable nesting species in the Garden in 1961–63, but was not seen at all during the 1995 to 1997 survey. It was recently added to the breeding list for St James's Park and now nests in all of the Royal Parks, although in relatively small numbers. Spotted flycatcher has also been lost as a breeding species in Kensington Gardens and Regent's Park, with just one pair holding on in Hyde Park. The Pied Wagtail has never been a regular nesting species in the Royal Parks, preferring to nest on buildings where a few pairs probably go unrecorded each year. One of the two pairs to nest in the Garden during 1961 reared young in an open flower vase on the terrace.

In summary, the changes noted in the bird species nesting in Buckingham Palace Garden over the last thirty years are similar to the changes observed in the Inner London Royal Parks. Of the breeding list for the Royal Parks, only Blackcap and Chaffinch might reasonably be expected to be found at Buckingham Palace Garden.

For 1996, data are available for the numbers of birds nesting in all of the Royal Parks of Inner London. This gives a unique opportunity to compare not only the species nesting in the Garden, but also the total numbers of birds at each site. Tables 4 and 5 show the number of breeding pairs in Buckingham Palace Garden directly compared with St James's Park, Hyde Park, Kensington Gardens and Regent's Park in the 1996 breeding season. Table 4 lists water birds and wildfowl; Table 5 lists land birds and passerines.

The Garden has the highest density of wildfowl, with St James' Park and Regent's Park close behind. The list (Table 4) excludes wildfowl collections, on the assumption that these birds are fed daily and are not dependent on the lake for food.

Availability of undisturbed nest sites is a significant factor in determining the density of wildfowl in these areas. Hyde Park has the lowest density, since the only nest site available is the Serpentine Island, where even the shy Great Crested Grebe nests successfully in a small area closed to boating. Some wildfowl require tree-holes in which to nest and there are few suitable trees in Hyde Park.

Numbers of birds in both St James's Park and Regent's Park are high, with the islands well maintained for the birds and ample food and plenty of nest-boxes providing ideal conditions for both wild and feral populations alike to nest.

TABLE 4. Breeding water birds and wildfowl in Buckingham Palace Garden and the Inner London Royal Parks in 1996. The totals exclude the wildfowl collections in St James's Park and Regent's Park.

Species	**Location**				
	Buckingham Palace Garden	**St James's Park**	**Hyde Park**	**Kensington Gardens**	**Regent's Park**
Grey Heron	—	—	—	—	20
Great Crested Grebe	1	—	1	—	7
Mute Swan	—	1	1	1	1
Greylag Goose	4-6	2	2	—	2
Canada Goose	4	2	26	4	6
Mallard	5	15	2	5	26
Pochard	1	10	7	3	12
Tufted Duck	3	20	2	12	10
Moorhen	2-3	6	2	3	12
Coot	4	7	2	5	14
Nesting pairs	24–27	63	45	33	110
Total water birds	48–54	126	90	66	220
Area of lakes (hectares)	1.6	4.6	11	4	8
Water birds per hectare of water	30–34	27	8	17	27

Buckingham Palace Garden has by far the smallest of the lakes, but nevertheless hosts a wide range of wildfowl, whilst the lack of disturbance increases the number of nesting sites, albeit no artificial food was provided in 1996.

A small collection of pinioned ducks and geese was introduced to the lake in 1997 with some artificial food now being provided in winter. It will be interesting to see if this extra food attracts more wildfowl to nest in the Garden. A few duck-boxes have recently been placed on the island.

Wildfowl numbers, however, can be misleading when it comes to comparisons between sites. In St James's Park, for example, there are about 150 wildfowl in the collection, the majority of which are pinioned. Many nest each year, but the offspring are no longer pinioned and when fully fledged some leave the park, with a few visiting Buckingham Palace Garden. Ringing has shown that some young birds disperse over a wide area, with recoveries from Kent, Norfolk, and northern France. The carrying-capacity on St James's Park lake is largely determined by the amount of artificial food and suitable nesting sites provided by the bird-keeper. The lake is, therefore, managed; the same is true for Regent's Park.

Turning to the land birds and passerines, Table 5 shows the numbers of breeding pairs or territories in Buckingham Palace Garden compared with similar data for the parks. Green Park is excluded as it has no shrubberies and very few birds except those nesting in gardens along its eastern boundary. The trees are mostly mature London plane, which tend to be shunned by the birds. Its open grassland provides a feeding ground for large numbers of Crows and Magpies that move in to Buckingham Palace Garden when the park gets busy.

Approximately half the species require shrubberies for food and nesting sites, while the remainder tend to nest high in the trees, in tree-holes, or on buildings. The breeding population of the Garden, excluding the water birds, is between 61 and 72 pairs, giving a density of between eight and ten birds per hectare. This is much higher than for all of the Royal Parks except St James's Park, which has a density of eight birds per hectare. Although the larger parks have a lower density of birds compared with the Garden, perhaps disturbance from the public is not a major factor. After all, the number of visitors walking through St James's Park is enormous, and yet the number of birds is almost as high as in the Garden.

Approximate areas of shrubberies at each site are as follows:

Buckingham Palace Garden	3 hectares representing 20 per cent of total site area
St James's Park	2 hectares representing 11 per cent of total site area
Hyde Park	4.4 hectares representing 3 per cent of total site area
Kensington Gardens	4.2 hectares representing 4 per cent of total site area
Regent's Park	3 hectares representing 2 per cent of total site area

This shows that the area given over to shrubs is much greater in St James's Park and Buckingham Palace Garden than in the larger parks. The shrubberies in the parks are enclosed and are usually free of disturbance. Birds would be able to feed throughout the parks in the early mornings and evenings, retreating to the seclusion of the shrubberies when the throng of visitors arrives.

From this evidence it would appear that it is the presence of undisturbed shrubberies, with suitable cover for nesting, feeding and roosting, that may control the number of birds, rather than whether the whole area is quiet and secluded. Having said that, even the Garden is full of visitors on occasions when thousands of people attend garden parties in the summer. By then most of the nesting has been completed.

TABLE 5. Breeding land birds in Buckingham Palace Garden and the Inner London Royal Parks in 1996: estimates of breeding pairs.

Species	**Location**				
	Buckingham Palace Garden	**St James's Park**	**Hyde Park**	**Kensington Gardens**	**Regent's Park**
(i) Mainly shrub-dependent species					
Goldcrest	—	—	—	—	2
Wren	6–7	7	5	6	12
Dunnock	1–2	2	3	3	16
Robin	7–8	9	11	20	18
Blackbird	12	12	26	38	15–18
Song Thrush	1-2	4	6	5	8–10
Blackcap	—	1	2	3	5–7
Spotted Flycatcher	—	—	1	—	—
Long-tailed Tit	1	2	2	3	3
Coal Tit	2	2	1	2	1
Blue Tit	10–11	9	16–19	18	15–20
Great Tit	3–4	4	7	15	8–10
Chaffinch	—	2	1	2	6
Goldfinch	—	—	—	—	1–2
Greenfinch	1	1	5	1	1
(ii) Species largely dependent on mature trees or buildings					
Woodpigeon	8–10	7–10	5–10	15–20	15
Stock Dove	—	—	—	3	3
Tawny Owl	—	—	1	1	3
Great Spotted Woodpecker	1	—	1	1	1
Sparrowhawk	—	—	—	—	1
House Martin	—	—	8	—	—
Kestrel	—	—	—	—	3
Mistle Thrush	1–2	1	5	4	8
Nuthatch	—	—	—	1	—
Treecreeper	—	—	1	1	—
Jay	1	—	1	1	3–4
Magpie	2–3	1	6	6	14–16
Crow	2	1	3–4	7	15–20
Starling	1–2	5–8	15–20	20–25	10–15
House Sparrow	1	3	20	40	8–12
Total pairs	61–72	73–79	152–166	216–226	195–227
Number of birds	122–144	146–158	304–332	432–452	390–454
Total area in hectares (excluding lakes)	14.5	18.7	146	112	164
Birds per hectare	8.4 – 9.9	7.8 – 8.4	2.1 – 2.3	3.9 – 4.0	2.4 – 2.8

Natural food availability and suitable cover for nest sites largely influence the numbers of birds at each site. This should answer the question as to whether the relatively undisturbed Buckingham Palace Garden is more desirable to nesting birds than the Royal Parks with their human pressures. Kensington Gardens has a higher density of birds than the adjoining Hyde Park, despite having a similar proportion of shrubberies. This can be explained by the different character of the two parks. There are a greater variety of mature trees in Kensington Gardens, most of which are native trees with a canopy covering 42 per cent of the park. This offers opportunities for woodland birds such as Stock Dove, Nuthatch and, in 1997, the newly arrived Green Woodpecker, to gain a foothold. In Hyde Park by contrast, since the loss of the elms in the 1970s, the majority of the mature trees are London planes, which are low food-providers for birds, and the canopy cover is only 23 per cent.

Conclusions

The study has shown that the size of Buckingham Palace Garden, at just sixteen hectares, is sufficiently large to monitor much of what is happening to the bird life throughout Inner London.

Changes in the species nesting in the Garden since the last survey in the 1960s almost exactly mirror the changes that had been observed in the much larger Royal Parks over the same period.

More surprising is the correlation of overall bird numbers. At one time it was thought that London's birds were somehow immune from what was happening in the countryside. Recently, falls in the numbers of some species nationwide have been shown to affect the London populations too.

Of particular concern is the decrease in numbers of what were regarded as common birds. Starling and House Sparrow were so common that very little is known about them. Few people bothered to record them. Studies like this can highlight these dramatic changes at an early stage.

This study has shown that the numbers of birds appear to be influenced not so much by the number of visitors, but more by the availability of undisturbed shrubberies and mature native trees. While little can be done to prevent the loss of species that are declining nationally, it is possible by continuing good management of the trees and shrubs, to create habitats that will encourage a greater variety of species to nest. Emphasis should be directed towards maintaining areas of dense cover in each of the shrubberies. The inclusion of hawthorn would be advantageous, both for cover and as a winter food source. Tree plantings should be confined as far as possible to native species that support the largest number of insects. The eventual replacement of the London plane, which originated in the Lebanon, and supports just one or two species of insect in this country, with native oaks, which support over 280 sspecies of insects, would in the long term be beneficial to all wildlife.

The Garden is a wonderful haven for wildlife. Even though there is no species nesting in the Garden that cannot be found elsewhere in London, the density of wild birds is probably higher than anywhere else in the capital.

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Mammals in Buckingham Palace Garden

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Abstract

The occurrence of six mammal species in Buckingham Palace Garden is documented. Comments are made on their status in the Garden and on the completeness of the recording effort.

Methodology

Mammals in Buckingham Palace Garden have been recorded using three survey techniques. A dusk visit to the Garden was made on 2 July 1996 and bats were recorded during optimal weather conditions for foraging using a standard 'Bat Box III' heterodyne bat detector. Secondly, the small terrestrial mammal population was surveyed during the night of 18/19 March 1998 using a total of forty standard Longworth live traps which were set in a variety of suitable habitats within the Garden. Finally, a number of casual observations, made in the years since the previous survey (Corbet 1964) were obtained verbally from Mark Lane, the Head Gardener.

The main constraint on the survey relates to the small-mammal trapping. This was undertaken at a time of the year when populations had decreased from their late-autumn peak and it is likely that some species may not have been encountered simply because they were present only in small numbers. Regrettably, there was no subsequent trapping in order to detect these species at a later date.

Survey results

The bat survey recorded several pipistrelles around the lake and occasional individuals elsewhere in the Garden. The work was undertaken before the pipistrelle was confirmed as two cryptic species (Barrett et al. 1997) which can usually be separated in the field on the basis of their peak echolocation frequency at either 45 or 55 kHz. During the survey, occasional encounters with individual bats were, however, too brief and too infrequent to be confident about whether a single species or both were present.

Small-mammal trapping resulted in the capture of only wood mice, with a total of six male, four female, three juvenile and one unsexed individual being recorded. This corresponds to a trap occupancy rate of 35 per cent.

A further four species, grey squirrel, house mouse, common rat and fox, were recorded by casual observations.

A final species, the field vole, which had been claimed independently by two observers in 1961, was rejected by G. B. Corbet when summarising the results of the original survey (Corbet 1964) and has never been reported since that date. The present author supports its exclusion from the species list given below.

Discussion

The six species of mammal reliably recorded from Buckingham Palace Garden compares with a total of 49 species (excluding pinnipeds and cetaceans) currently on the London Area list (Herbert 1996). There are no unexpected records and the list compares somewhat unfavourably with other urban open spaces, such as Hyde Park and Holland Park. Both of these two sites have additional species present, including hedgehog *Erinaceus europaeus*, noctule *Nyctalus noctula* and introduced rabbits *Oryctolagus cuniculus*, as well as resident populations of species which have only an occasional status in the Garden. The fox and common rat fall into this latter category. The lack of ground cover in the Garden, together with the difficulty in colonisation, may also prevent other small mammal species from becoming established.

It is considered that a more extensive trapping programme would have confirmed the continuing presence of house mouse and further attention to the low numbers of bats present may result in confirmation that both pipistrelle species occur here. With these exceptions, however, it is considered that the full mammal fauna of the site has now been documented.

The only mammal present in the garden of conservation significance is the pipistrelle which is a National Biodiversity Action Plan species and is included in the *Red Data Book* by Morris (1993) along with all other British bats.

Species list

A total of six mammal species has been reliably recorded from the Buckingham Palace Garden. The nomenclature follows Corbet and Harris (1991). Species recorded in the previous survey, but not found in the present study, are shown enclosed in round brackets.

CHIROPTERA

Vespertilionidae

Pipistrelle *Pipistrellus pipistrellus*

Small numbers of this bat, which has subsequently been separated into two species, have been recorded foraging in the Garden. Its occurrence there was correctly anticipated by G.B. Corbet when he summarised the mammals recorded during the earlier survey (Corbet 1964).

RODENTIA

Sciuridae

Grey squirrel *Sciurus carolinensis*

This species is present all year. It sometimes nests in the Garden and individuals are also reported to move in from nearby Green Park (M. Lane, pers. comm.).

Muridae

[Arvicolinae]

[Field vole *Microtus agrestis*

A 1961 record of this species from the Garden is considered unreliable and was rejected by Corbet (1964). No new evidence has come to light to disagree with Corbet's opinion.]

Murinae

Wood mouse *Apodemus sylvaticus*

The most numerous small mammal in the Garden, where it is present in good numbers.

(House mouse *Mus domesticus*

This species was one of only two mammal species confirmed as being present in the Garden during the 1961–63 survey. It was not recorded during trapping in 1998, and the only records available are the observations of Head Gardener Mark Lane from a few years earlier than this. There is no reason to suppose that it is no longer present and any future survey in an appropriate season is likely to turn it up.)

(Common rat *Rattus norvegicus*

This species was also recorded during the earlier survey when it was thought to occur as an occasional immigrant, and was quickly eliminated. Since that first survey, one individual was recorded during the mid 1980s (M. Lane, pers. comm.) when it was observed digging up tulip bulbs and found to be nesting at the back of the Rose Garden.).

CARNIVORA

Canidae

Fox *Vulpes vulpes*

This species is widespread throughout the surrounding area of central London and occurs in the Garden as an occasional immigrant, which is then actively deterred to prevent breeding (M. Lane, pers. comm.). One individual made the national news in 1996 when it killed the flamingos kept on the lake (R. Sanderson, pers. comm.).

Acknowledgements

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PLATE B. Buckingham Palace Garden, London. View from Mudhole, looking across The Lake towards the Rose Garden, summer 1998. *Photographed by Mark Lane.*

The molluscan fauna of Buckingham Palace Garden

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Abstract

Between March 1996 and May 1998, a study was made of the molluscan fauna of Buckingham Palace Garden. Sixteen terrestrial species and five freshwater species of gastropods were recorded. The alien slug *Lehmannia valentiana* (Férussac, 1823) was recorded living in the open. The factors influencing distribution within the habitat are considered, as are those which may influence the constituent taxa within the assemblage.

Introduction

The data upon which this paper is based resulted from visits to Buckingham Palace Garden by myself and my wife on 18 March, 20 May, 30 September 1996 and 3 September 1997, together with material passed to me by Alick Henrici, Mark Lane and Colin Plant. Mary Spencer-Jones supplied some records of *Bithynia tentaculata* and *Planorbarius corneus*.

Materials and methods

The majority of the terrestrial gastropods were recorded by searching suitable habitats within the Garden, and by collecting leaf-litter and soil for drying and sieving later through nylon mesh sieves with mesh apertures of 2 mm and 0.5 mm. Recording was considered complete for the visit when no new species were found after a minimum of thirty minutes additional searching. A few specimens were collected from pitfall-traps set to collect other groups, or were found during field work by others, and these were forwarded to me for identification and inclusion in the records.

The freshwater species were recorded by collecting from the bank of The Lake using a 25 cm diameter nylon mesh scoop, with a mesh aperture 0.5 mm, on a 1.5-metre aluminium pole. The contents of the scoop were examined in fresh water in a shallow white dish. Also, samples of water weeds were collected, washed with fresh water and the washings examined in a shallow white dish. Recording was considered complete for the visit when no new species were found after a minimum of thirty minutes additional searching.

All records included the local grid reference and details of the habitat.

Results

A total of eighty-five specimens of molluscs was collected in the Garden, representing twenty-one species; sixteen terrestrial and five freshwater species. Details are summarised in Table 1.

Discussion

Terrestrial species

Approximately 125 terrestrial species of molluscs are currently recognised as occurring naturally in Britain (Kerney 1976b).

Whilst not analogous to a woodland, the large mature garden may be compared to one when considering the molluscan fauna since it contains many similar elements, including mature trees, an under-storey of shrubs and some ground cover, even if the flora is composed mainly of introduced species and cultivars. Buckingham Palace Garden also includes a large expanse of closely mown lawn, but none of the molluscs recorded in the present study as found within the area of the lawn, and so it seems reasonable to discount it for present purposes. However, it does cover a large area and exposes the surrounding beds and borders to the drying effects of the wind, a factor which will be referred to again.

TABLE 1. Summary of numbers of specimens of species recorded and habitats in which they were found.

Species	**Number of specimens**	**Habitat**			
		Under wooden sleepers, planks or flower pots	**In leaf litter or soil**	**In lake**	**Other**
Aegopinella nitidula	1		1		
Arion hortensis	5		5		
Arion intermedius	2		2		
Bithynia tentaculata	9			9	
Cepaea hortensis	1				1
Deroceras reticulatum	2		1		1
Ferrissia wautieri	3			3	
Gyraulus albus	7			7	
Helix aspersa	10		8		2
Hippeutis complanatus	1			1	
Lehemannia velentiana	14	12			2
Limax flavus	2	2			
Limax maximus	1				1
Oxychilus alliarius	1	1			
Oxychilus cellarius	13	3	8		2
Oxyloma pfeifferi	1				1
Planorbarius corneus	1			1	
Punctum pygmaeum	2		1		1
Tandonia sowerbyi	5	3	2		
Testacella scutulum	1	1			
Vitrina pellucida	3		3		
Totals	**85**	**22**	**31**	**21**	**11**

Some of the most species-rich sites for terrestrial molluscs are woodlands in north-east England, containing some nationally scarce species, and which have a mean number of species per site of 29.06 ± 1.49; range 19 to 39 (Wardhaugh 1996). In that study, species richness was shown to be positively associated with woodland area, moisture level and age. The association of species-rich mollusc faunas with alkaline soils is well known (Boycott 1934), although it is clear from more-recent studies that it is the availability of calcium salts in the leaf litter rather than the alkalinity of the soil which is important (Wäreborn 1969, Bishop 1977).

In the south of England species-rich sites may be found on the scarp slopes of the South Downs. Thirty-six species were recorded at such a site in West Sussex (Willing 1986).

Only sixteen terrestrial species were found on the site in the present study, and with eight of these being slugs, Buckingham Palace Garden must be considered a relatively poor site for molluscs. The possible reasons for this will be considered later in this article.

Castell (1962) provides a historical overview of molluscs of the London area, but adds little to our understanding of the ecology of molluscs in an urban environment. Six of the sixteen species recorded in the present study, namely *Arion hortensis*, *Tandonia sowerbyi*, *Limax maximus*, *L. flavus*, *Testacella scutulum* and *Helix aspersa* are included by Boycott (1934) in a group as associated with houses and gardens. Although they were not found during this study, the previous survey (Bristowe 1964) recorded *Oxychilus draparnaudi* and *Tandonia budapestensis*. Both of these are also included in Boycott's group of molluscs associated with houses and gardens. To this assemblage we may add *Lehmannia valentiana*. This species has been known in Britain as a greenhouse alien for some time. It originates from the Iberian peninsula and was first found in the British Isles in the Botanical Gardens at Belfast in 1948 (Quick 1960, referred to as *Limax poirieri*). It has only very occasionally been found living in the open as an escape (Kerney and Cameron 1979). During the present study it was found on each occasion the site was visited, in widely scattered localities, and at a frequency of from one to four individuals at each locality, suggesting it is firmly established in Buckingham Palace Garden. It has since been found living in the open at a few sites in Somerset (Buckle 1998) and it has also been reported from a garden in Woking, Surrey (Nelson pers. comm.).

The absence of *Oxychilus draparnaudi* and *Tandonia budapestensis* from the present study may be explained by their 'transitory' nature. From observations in my own garden, they occur for a year or two, are not seen for several years and then come back again, without any obvious reason.

Locations of terrestrial species within the Garden

Boycott (1934: 8) is of the opinion that the main considerations are shelter and lime, and defines shelter as 'such conditions as secure damp air and provide nooks and crannies into which Mollusca can retire to escape drought and cold and lay their eggs.' The data obtained in this study, although insufficient to warrant statistical analysis, tend to support the view that shelter is a major factor in the distribution of molluscs within a habitat.

Only one record was from an area more than approximately 25 metres from the boundary wall, and that was from a rotting herbaceous stem near The Lake. The majority of records came from within approximately 10 metres of the boundary wall. The significance of the boundary wall appears to be that, not only is the area adjacent to it the least 'maintained', 'tidied' and 'managed', but the rear of most of the borders is supported by old wooden railway sleepers and planks of timber, thereby providing the necessary shelter and moist air for the molluscs. Twenty-two specimens, representing six species, were found sheltering under the sleepers and planks, or under flowerpots close to them.

The importance of an extensive system of moist interstices in the leaf litter, the vigour of the decomposer cycle and the concentration of calcium salts upon the distribution of terrestrial molluscs has been shown by Berry (1973). Some of the borders and flower beds in the Garden are frequently mulched with compost, making the leaf litter in those borders more congenial to molluscs. Thirty-one specimens, representing nine species, came from such areas. Five specimens representing four species were recorded from leaf litter which had collected in a sheltered area adjacent to the wall. In those borders and flower beds which are exposed to the drying effects of the wind, i.e. those near the lawn and without a layer of compost, only two specimens were found, one of *Oxychilus cellarius* and one of *Cepaea hortensis*.

The soil of the Garden is probably derived from flood-plain meadows overlying river gravel or sands. The soil pH of the borders and beds was in the range 5.0–6.8, measured in September 1998 (Bowlt pers. comm.). Whilst it is probable that it is the availability of calcium salts which influences the distribution of gastropods within a habitat, acid soils appear to be more favourable to slugs than to heavily shelled snails. It is worthy of note that of the eighteen terrestrial species recorded in the two surveys, nine are slugs, six have very thin shells (*Oxyloma pfeifferi, Vitrina pellucida, Aegopinella nitidula, Oxychilus draparnaudi, O. cellarius, O. alliarius*), one is extremely small (*Punctum pygmaeum*) and it is only *Cepaea hortensis* and *Helix aspersa* which have substantial shells. It is possible that both these species may obtain the necessary calcium by rasping the shells of their dead brethren, behaviour which I have observed in *H. aspersa* in sand dunes, and which has been reported for *C. nemoralis* by Pitchford (1955).

The data obtained in this study support the view that the main factors influencing the distribution of terrestrial molluscs within a large garden, are shelter and moisture. Further, in such a habitat it appears that low soil pH favours a molluscan assemblage composed of slugs and thin-shelled snails. However, details of the soil and leaf litter chemistry, together with data from a number of gardens are required in order to investigate this.

Freshwater species

Seventy-four species of molluscs are presently recognised as occurring naturally in fresh and brackish water in Britain (Kerney 1976*b*). Seven of these are confined to brackish water, leaving 39 species of gastropods and 28 species of bivalves to consider.

In Britain the natural life span of the majority of pulmonate gastropods is 9–15 months or less. The operculates are also presumed to be annuals, except for *Viviparus* species, which have been kept for up to five years in captivity (Boycott 1936).

Gastropods spend their active lives living in quite shallow water, from a few centimetres to half a metre or so, occupying a narrow zone around the edge of the water body, which is also where most of the emergent vegetation occurs. The sampling technique employed in this study was therefore considered adequate for present purposes.

No bivalves were recorded from The Lake during the present study despite searching through the mud on the bottom as far as the pole and nylon scoop would reach, and none had been recorded in the previous survey (Evans et al. 1964). Nor were any were encountered by Colin Plant, who netted The Lake extensively, including the central area, whilst searching for aquatic insects on 20 October 1995. The absence of bivalves suggests anaerobic bottom conditions (Kerney and Stubbs 1980) and examination of the mud extracted in the search was also indicative of such conditions, although it was not tested.

The Lake is frequented by ducks and Canada geese. Waterfowl can completely destroy all molluscs in a pond or ornamental water by the putrefactive fouling of the water as much as by actual eating (Boycott 1936). Gastropods were recorded only from the area close to the artificial waterfall, which would suggest that only in that area was the oxygen level high enough to support them.

The molluscs collected included *Bithynia tentaculata, Gyraulus albus, Hippeutis complanatus* and *Planorbarius corneus* which are all species commonly associated with rather inferior loci such as ornamental ponds and lakes in the south of England. *Potamopyrgus antipodarum* and *Armiger crista* had been recorded in the previous survey but could not be found during the present study. Both of these are also commonly found in ponds and lakes in southern England.

Ferrissia wautieri was found on stones and on the underside of *Nymphaea* leaves in the area close to the waterfall. This small freshwater limpet was first recorded in Britain in 1976 (Brown 1977) and has since been found most frequently in artificial ponds and lakes, but occasionally occurs in natural waters (Preece and Wilmot 1979; Falkner and von Proschwitz 1998).

List of Mollusca recorded from Buckingham Palace Garden

The species recorded are included in the list below, which follows Waldén (1976) for terrestrial species and Kerney (1976a) for the freshwater species. Those species which have been recorded both in the present study and in the previous survey (Bristowe 1964; Evans et al., 1964) are preceded with an asterisk. Species recorded in the previous survey, but not found in the present study, are shown enclosed in round brackets. None of the species recorded is a *Red Data Book* species, (Bratton 1991); nor is any considered to be under threat or in need of conservation action at present.

TERRESTRIAL SPECIES

GASTROPODA

EUTHYNEURA

Succineidae
Oxyloma pfeifferi (Rossmässler, 1835)

Endodontidae
Punctum (Punctum) pygmaeum (Draparnaud, 1801)

Arionidae
* *Arion (Kobeltia) hortensis* Férussac, 1819
Arion (Kobeltia) intermedius Normand, 1852

Vitrinidae
Vitrina (Vitrina) pellucida (Müller, 1774)

Zonitidae
Aegopinella nitidula (Draparnaud, 1805)
(*Oxychilus (Oxychilus) draparnaudi* (Beck, 1837))
* *Oxychilus (Oxychilus) cellarius* (Müller, 1774)
Oxychilus (Ortizius) alliarius (Miller, 1822)

Milacidae
Tandonia sowerbyi (Férussac, 1823)
(*Tandonia budapestensis* (Hazay, 1881))

Limacidae
Limax (Limax) maximus L., 1758
Limax (Limacus) flavus L., 1758
Lehmannia valentiana (Férussac, 1823)
* *Deroceras (Agriolimax) reticulatum* (Müller, 1774)

Testacellidae
Testacella (Testacella) scutulum Sowerby, 1821

Helicidae
Cepaea hortensis (Müller, 1774)
Helix (Cornu) aspersa Müller, 1774

FRESHWATER SPECIES

GASTROPODA

PROSOBRANCHIA

Hydrobiidae
(*Potamopyrgus antipodarum* (Gray, 1843))

Bithyniidae
* *Bithynia tentaculata* (L., 1758)

EUTHYNEURA

Planorbidae

* *Gyraulus albus* (Müller, 1774)
(*Armiger crista* (L., 1758))
Hippeutis complanatus (L., 1758)
Planorbarius corneus (L., 1758)

Ancylidae

Ferrissia wautieri (Mirolli, 1960)

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Spiders and other Arachnida in Buckingham Palace Garden

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Abstract

A survey of the Buckingham Palace Garden for arachnids other than mites was carried out. A total of 112 species of spider, one pseudoscorpion and six harvestmen was collected. The species list was compared with that from an earlier survey, showing that around two thirds of the earlier species were rediscovered, but a substantial number (seventy-one spiders, one pseudoscorpion and five harvestmen) of new records were made. Some observations are made about the rather anomalous spider fauna and some possible explanations for the nature of the existing assemblage and the apparent changes since the 1964 survey are given.

Introduction

Records of spiders from Buckingham Palace Garden go back to W. S. Bristowe's first visit there in May 1929 when he collected twenty-nine species; by 1964, fifty-seven species had been recorded (Bristowe 1964). The present total stands at 131 species, although some of these are probably no longer present today and the list includes records of others that may never have been established and may have been brought into the Garden on plants or with soil. Bristowe himself suggested that some of the spiders that he listed in 1964 came into this category.

A single species of pseudoscorpion (Pseudoscorpiones) and a single harvestman (Opiliones), were also recorded from the Garden by Bristowe; brief reports on these two groups follow the account of the spiders.

In this report the nomenclature used for spiders follows Merrett *et al* (1985) with amendments by Merrett & Millidge (1992) and Nellist (1998). Where different names were used by Bristowe, these have been included in brackets. The nomenclature for pseudoscorpions follows Legg and Jones (1988) and that used for harvestmen follows Hillyard and Sankey (1989).

Personnel, materials and methods

In the course of this study, a number of visits were made to the Garden by the author and by David Nellist for the purpose of searching for, or pitfall-trapping, spiders. Colin Plant set some pitfall traps for a short time, collected some spiders while searching for insects and found some spiders in the Malaise trap: of these some were identified by Peter Harvey, others by the author. Finally the Head Gardener, Mark Lane, sent the author a number of specimens.

Various methods were used to collect spiders in the Garden, including grubbing about, sorting dead leaves and matted vegetation, beating and sweeping grass and other ground herbage, bushes and the lower branches of trees and shrubs. The author set some standard trios of pitfalls (Milner 1987) with a small quantity of ethylene glycol in the form of commercial anti-freeze and a wetting agent (commercial detergent) in each. The traps were set at four sites:

Site A — in low vegetation on the marshy edge of The Lake;
Site B — in a small area of short grass, partly shaded, inside the flamingo enclosure;
Site C — in partly shaded grass with anthills on top of The Mound;
Site D — in long grass on the north facing slope of The Mound.

The positions of these pitfall traps, and of those set elsewhere in the Garden by Colin Plant, are indicated in the map on pages 2 and 3.

All the sites were at least partly shaded, and were subject to mechanical mowing at least once per season, some more often. On more than one occasion some of the traps were damaged by the mowing machine, even at site D on quite a steep slope.

The pitfall traps were operated from July 1995 to the end of May 1997, being emptied and the catch sorted on a monthly basis.

Results

Spiders

As a result of this work, 112 spider species were recorded in the Garden during the period 1995-98. Of these, forty-one were species already recorded by Bristowe (including *Clubiona terrestris* which he omitted from the 1964 report) and seventy-one were species recorded in the Garden for the first time. A further seventeen species recorded by Bristowe in the Garden and buildings (including the cellars) were not found again. The total species list for the Garden therefore comprises 129 species of spider. Most of the spiders recorded are common species, but in addition there were three Nationally Notable species (Merrett 1990): *Zilla diodia*, *Porrhomma errans*, both recorded here for the first time in London and *Nigma walckenaeri*.

Results of pitfall-trapping

From the results of the standardised pitfall-trapping, an arbitrary twelve-month period, from 10 January 1996 to 10 January 1997, was selected so that comparisons with other 12-month catches could be made (Milner, in press). The overall results are given in Table 1 and details of the most frequently trapped species are given in Table 2.

The results from the four sites varied considerably, both in numbers and in species richness, with site C producing the highest total of both individuals and species, while site B, with the lowest scores for both, is clearly a relatively impoverished site. This may be partly due to the fact that the grassy area, although well-established, is very small, at about 4 x 1.5 metres. Site C, on the other hand, is clearly a much richer site, and the presence of an anthill at the beginning of the trapping period (it was later destroyed by the mowing), suggests a lower level of disturbance at least in the period preceding the trapping.

Comparing the data in Table 1 with data from 12-month samples at 82 pitfall-trapping sites around London (Milner, in press), Site A, which is categorised as wetland, produced 204 spiders of 25 species, compared with a mean for London of 301 spiders of 25.2 species.

TABLE 1: Pitfall-trapping at four sites in Buckingham Palace Garden: detail of sites and overall results from the period 10 January 1996 to 10 January 1997.

Site	Habitat	Estimated disturbance level	Total number of spiders	Number of species	Number of pioneer spiders (W)	Number of grassland spiders (G)	W/G
A	Low vegetation on marshy border of The Lake	high (mown twice)	204	25	83	16	5.2
B	Short grass in flamingo enclosure (part shaded)	medium (mown once)	168	19	16	46	0.35
C	Short grass with anthills on top of The Mound (part shaded)	medium (adjacent to mown grass)	364	35	22	21	1.05
D	Long grass on north-facing slope of the Mound	high (mown twice)	220	28	28	0	-

The mean score for short-grass sites is 892 spiders of 26.2 species. Sites B and C, which both come into this category, score very differently with only 168 spiders of 19 species for site B in the flamingo enclosure, and 364 spiders of 35 species for site C on top of The Mound. This is a particularly high score for species richness, well above the mean of 30.7 species per 12-month sample for all London grassland sites. Site D, in long grass on the slope of The Mound, scored 220 spiders of 28 species, which compares with the mean of 681 spiders of 30.8 species for long-grass sites in London.

One method of comparing grassland sites and their likely conservation value used by the writer (Milner 1993), is to count the numbers of seven pioneer or 'weed' spiders (*Oedothorax fuscus, Oedothorax retusus, Milleriana inerrans, Erigone dentipalpis, Erigone atra, Bathyphantes gracilis* and *Lepthyphantes tenuis*) present in a 12-month catch (value W). This can then be related to value G: the numbers of grassland specialists (defined as the lycosids) present. Sites where W/G is less than 1 are taken as reasonably healthy while those where W/G is greater than 1 are understood to be disturbed (and relatively unhealthy).

The values for W/G at these sites are given in the last column of Table 1, but the results are inconclusive. The number of pioneer species (W score) is lower than expected for all the sites, but the number of grassland spiders is also low. However, the predominance of pioneers at site A suggests that, although damp and marshy, this location has a spider assemblage that is untypical, presumably due to the high level of disturbance affecting it more than the grassland sites.

More telling, perhaps, is the species composition of the catch at each site. Table 2 lists all the species trapped at three or more sites and gives the total for each species in the sample 12-month trapping period. Six species were trapped at all four sites in the sample period: *Enoplognatha thoracica, Pachygnatha degeeri, Micrargus subaequalis, Panamomops sulcifrons, Centromerita bicolor* and *Lepthyphantes tenuis*. Of these, perhaps the most surprising was *P. sulcifrons*, the tiny 'horned' spider, known for the unique feature of two, pointed protuberances on either side of its head. This species is often overlooked, as it appears to live deep in the vegetation, but in recent years it has been taken in pitfall traps in most parts of London. A number of other species occurred at all four sites, but not within the sample 12 month period. These were *Oedothorax fuscus, Diplocephalus latifrons, Erigone dentipalpis, Diplostyla concolor* and *Linyphia clathrata*.

At site A, the species list was most atypical of similar wetland and wetland fringe sites in London. Nine similar sites in London parks and public open spaces have been trapped for 12 month periods (Milner, in press), and a list of the ten most frequent species made. Only four of these ten are present at Buckingham Palace Garden, and even *Pachygnatha clercki*, present at all other such sites, is absent. However, unlike the other wetland/wetland fringe sites sampled, site A is unusual in being subjected to regular mowing and this probably has a negative effect on the spider fauna.

At the grassland sites, common species were also missing from the pitfall samples: site B lacked five of the ten commonest species found in other shaded grass sites in London, while site C lacked four of the ten. At site D, in long grass, only 5 of the 10 commonest species found in this habitat elsewhere in London were trapped, and most of the missing species were large ones (*Alopecosa pulverulenta, Pardosa amentata, Pachygnatha clercki*) all species likely to be affected most by regular mowing. Some, though not all, of these 'missing' species did occur in the Garden somewhere, but were found in such small number or in such limited areas, that trapping at sites A, B, C and D did not reveal them.

When the species lists are compared with those from the fourteen most disturbed grass sites elsewhere in London, seven of the ten most commonly found species (pioneer species and disturbed ground specialists) were also found at site A, eight at site D, nine at site B and all ten were taken at site C. This suggests that disturbance is one of the most important factors influencing the occurrence of spiders at these sites in the Garden.

TABLE 2. Pitfall-trapping at four sites in Buckingham Palace Garden: a list of all species trapped at 3 or more sites.

Numbers given are the totals trapped in 12-month period 10 January 1996 to 10 January 1997. An asterisk (*) indicates specimens trapped at the site outside the 12-month period.

Species	Site A	Site B	Site C	Site D
Clubiona terrestris	1	—	5	4
Pardosa pullata	8	40	9	—
Alopecosa pulverulenta	8	*	12	—
Enoplognatha thoracica	2	1	9	3
Pachygnatha degeeri	47	15	148	44
Oedothorax fuscus	*	*	*	1
Monocephalus fuscipes	*	—	1	7
Micrargus herbigradus	*	1	—	4
Micrargus subaequalis	2	8	2	11
Diplocephalus latifrons	*	4	*	29
Panamomops sulcifrons	1	7	2	1
Milleriana inerrans	—	*	*	*
Erigone dentipalpis	13	2	4	*
Erigone atra	—	*	2	1
Meioneta saxatilis	—	2	1	10
Centromerita bicolor	28	39	91	42
Microneta viaria	1	*	1	—
Bathyphantes gracilis	5	5	—	*
Tapinopa longidens	2	—	1	1
Stemonyphantes lineatus	1	—	4	1
Diplostyla concolor	2	24	4	*
Lepthyphantes tenuis	65	9	16	26
Lepthyphantes flavipes	4	—	4	3
Lepthyphantes ericaeus	1	*	—	5
Lepthyphantes pallidus	1	—	2	1
Linyphia clathrata	2	2	*	2

Discussion

In Bristowe's report for the 1964 survey he remarked that 'The spider fauna of the Garden is specially interesting for its absentees. Any garden of this area and nature outside the built-up area of a city would be expected to have a number of other species, and a greater abundance of others which are scarce.........'. Among the absentees that Bristowe expected to find were *Dysdera (crocata)*, *Drassodes (lapidosus)*, several species of Lycosidae, *Theridion sisyphium, Tetragnatha* spp., *Metellina (Meta) segmentata* and at least two species of *Linyphia*. Interestingly, most of these species have subsequently been found, and some of them, in particular some lycosids, are today fairly common throughout the Garden (except on the lawns) — though they were clearly absent 35 years ago. He went on to suggest that perhaps the missing species 'were unable to survive the soot deposits and acidity of the soil'. This may have been the situation only a short time after the first Clean Air Act of 1956, but neither of these environmental hazards are a major problem in the Garden today.

Bristowe's list of spiders, if it was the list for a site today, would suggest a highly disturbed and impoverished habitat. *Oedothorax retusus, Erigone dentipalpis, E. atra, Meioneta rurestris* and *Diplostyla (Bathyphantes) concolor* were all 'common' according to his observations, while apparently there were few other linyphiids and hardly any lycosids. Among the species which he found to be 'scarce' were some which are among London's commonest and most abundant species (such as *Bathyphantes gracilis* and *Lepthyphantes tenuis*). Others such as *Diplocephalus cristatus* are still present, but are rather scarce today in London. Some species such as *Centromerita bicolor* and *Macrargus rufus* were probably missed because they are winter-active species that are rarely seen in the summer.

No pitfall-trapping was done in the Garden in the 1960s, so some of the smaller species could well have been missed, but some of the larger linyphiids such as *Walckenaeria acuminata* and *Stemonyphantes lineatus* are not at all difficult to find by hand searching. Were they present, but missed by Bristowe because they were so scarce? Or were they absent at that time and have recolonised the Garden since the 1960s?

There may have been quite substantial changes in the spider fauna of London in the past few decades, and in addition the management of the Garden has probably changed a great deal. For example, Bristowe's list suggests that there was little or no long grass extant in the 1960s. Presumably the mowing regime was strict and general 'tidiness' of the Garden more rigorously interpreted than is customary today — except possibly around the edge of The Lake. Evidence for these observations includes the absence from Bristowe's list of normal grassland lycosids such as *Pardosa pullata, P. palustris and Alopecosa pulverulenta* (today three of the commonest spiders in London), which are all found in reasonable numbers in the Garden today. Even *P. prativaga*, which was 'not established' in the 1960s, is now clearly part of the spider fauna in the Garden, though it is scarce.

The presence of two marshland *species (Pirata piraticus* and *Gnathonarium dentatum)* in Bristowe's list, neither of which appear to be present today, suggests that there was some lakeside vegetation which remained unmown through the season; this is not the case today. The pitfall-trapping within a foot of the edge of The Lake by the author was particularly disappointing, as it resulted in catches which were almost completely devoid of species with any affinity to normal marshland or pond-sides.

Implications for conservation

In terms of managing the Garden for the conservation of spiders and other arachnids, and to encourage and enhance these faunas, any means of allowing some areas of open grassland to remain permanently uncut would be most helpful. Many species present in the Garden seem to be surviving at very low population levels and any relaxation of the mowing and other disturbance would benefit many species. It should allow spider assemblages which are nearer to those occurring in less disturbed grassland in London to develop, with the numbers of pioneers dropping and being replaced by greater numbers of typical grassland species. Some of the larger species, such as *Tetragnatha* spp. and *Araneus* spp., depend on tall herbs and grass remaining undamaged through the winter for their eggs or hibernating adults to survive. Without this they are always going to be very vulnerable in the Garden. Exactly how disturbance affects smaller species is not known, but even among the small ground-living spiders it is clear that reduced levels of disturbance benefit many species, while high levels of disturbance favour only a few pioneers.

Ideally, the banks of The Lake should also remain unmown and uncut. This would give an opportunity for a normal lakeside or pond-side vegetation to develop. This would not need to be a wide band of such vegetation, a metre or so would be quite adequate, but it could over time result in the build-up of a normal marshland spider community, some of whose members were present in the 1960s. How long this would take is not known, but might be as little as a few years.

Pseudoscorpions

One new pseudoscorpion, *Roncus lubricus*, was found in mossy grass on The Mound, but the single species previously recorded by Bristowe, *Neobisium muscorum*, was not found again.

Harvestmen

Six species of harvestman were recorded, of which only one, *Phalangium opilio*, had been previously recorded.

An annotated list of Arachnida (excluding Acari), recorded in Buckingham Palace Garden

All records are by the author unless stated. Where the name used by Bristowe (1964) has since been superseded the earlier name is given in brackets. Species found in the earlier survey, but not found during the present study, are shown enclosed in round brackets. Taxa recorded in both surveys are indicated by an asterisk. Nationally Notable category A (Na) and category B (Nb) species are those listed by Merrett (1990).

ARANEA

Amaurobiidae

* *Amaurobius fenestralis* (Stroem, 1768)

This species was apparently common in London at one time: it appears to be relatively scarce today. Bristowe reported it as common under bark in the Garden, but today it appears to have largely been replaced by *A. similis*, and even to some extent by *A. ferox*. In the course of the present study a single individual was found, whereas both the other *Amaurobius* species appeared regularly in pitfall traps at several sites.

* *Amaurobius similis* (Blackwall 1861)

Common according to Bristowe, and frequent on walls and under bark today.

Amaurobius ferox (Walckenaer, 1830)

Not recorded by Bristowe, but during this survey found commonly under logs and in similar places.

Dictynidae

Dictyna uncinata Thorell, 1856

Common in long grass and herbs, especially early in the season.

* *Nigma walckenaeri* (Roewer, 1951) (*Dictyna viridissima*)

Swept and beaten from bushes and tall herbs, but uncommon today as in the 1960s. A nationally Notable (category Na) species.

Oonopidae

* *Oonops pulcher* Templeton, 1835

Common under bark today as in the 1960s

(*Oonops domesticus* de Dalmas, 1916)

'One specimen in the Gardener's office' (Bristowe); not seen in the Garden since.

Dysderidae

(*Dysdera erythrina* (Walckenaer, 1802))

A single specimen amongst flowerpots in a greenhouse 'apparently recently imported, and not established here' (Bristowe). Not seen since.

Dysdera crocata C. L. Koch, 1838

Both sexes trapped in mossy grass on top of The Mound, and also collected from among dead leaves. Its presence was predicted by Bristowe.

* *Harpactea hombergi* (Scopoli, 1763)

Common under bark, since the 1960s.

Segestriidae

Segestria senoculata (Linnaeus, 1758)

A single specimen found in its web during this survey in May 1998 on a large plane tree near the Tennis Court.

* *Segestria florentina* (Rossi, 1790)

'On the outside of the walls from 1946 to 1949 only' (Bristowe). This species appears to have been expanding its range in London (Milner 1995), and was rediscovered on the inside of walls around the Garden by Mark Lane in 1997.

Pholcidae

(*Pholcus phalangioides* (Fuesslin, 1775))

Both this species and the next were found by Bristowe in the cellars. So far no contemporary search of the cellars has been made, and neither species has been seen in the outbuildings.

(*Psilochorus (Physocyclus) simoni* (Berland, 1911))

Found by Bristow in cellars.

Gnaphosidae

* *Drassodes lapidosus* (Walckenaer, 1802)

The original record was a single immature specimen probably imported with soil: during this survey a single specimen was found in the Malaise trap in 1996.

(*Scotophaeus (Herpyllus) blackwalli* (Thorell, 1871))

Bristowe found this species in the Gardener's offices. It has not been seen in recent times, but may occur around the older buildings or under bark.

* *Micaria pulicaria* (Sundevall, 1832)

This species is associated with ants and is fairly widespread in London. Bristowe found 'several running on a southern (facing) bank'. A single male was trapped during this survey near The Lake in May 1997.

Clubionidae

* *Clubiona corticalis* (Walckenaer, 1802)

Common under bark of the larger trees since the 1960s.

(*Clubiona reclusa* O.P.-Cambridge, 1863)

'On shrubs' according to Bristowe: not seen recently, although it is fairly common in London.

Clubiona pallidula (Clerck, 1757)

Not recorded in London until May 1996 when two males were swept from vegetation, one was found in the Malaise trap and a substantial colony was seen under the eaves of a wooden shed inside the flamingo enclosure. Unfortunately, this building was subsequently demolished and the timber taken away. It is hoped that this species has survived elsewhere in the Garden as this is still the only known site for the species in the county. It has been recorded since: David Nellist found a single male under the cover of the Sand-Pit in May 1998.

Clubiona phragmitis C. L. Koch, 1843

Not recorded by Bristowe, but during this survey a few specimens were taken among vegetation near The Lake in 1995 and 1997.

Clubiona terrestris Westring, 1851

This common species is recorded by Savory & Le Gros (1957) as occurring at Buckingham Palace, but does not appear in Bristowe's list from 1964. During this survey, several specimens were trapped at sites A, C and D; it is fairly common among vegetation in the shaded parts of the Garden.

Clubiona compta C. L. Koch, 1839

Not recorded by Bristowe; during this survey it was found infrequently on The Mound and elsewhere among denser vegetation. This species, like *C. brevipes*, is known to spend much of the summer in the upper parts of trees and bushes.

* *Clubiona brevipes* Blackwall, 1841

Beaten from trees and occasionally under bark; recorded by Bristowe and found infrequently during this survey.

Liocranidae

Phrurolithus festivus (C. L. Koch, 1835)

Not recorded by Bristowe. This species is an ant mimic and is usually found near ants' nests. A single female was found by David Nellist underneath sheets of chipboard near the recycling centre in May 1998, and he later (June) found both sexes among vegetation at a number of points around the edge of The Lake. No specimens were taken in pitfall traps.

Thomisidae

* *Xysticus cristatus* (Clerck, 1757)

Common in all but the shortest grass in most parts of the Garden since the 1960s.

Xysticus kochi Thorell, 1872

Not seen by Bristowe. In this survey a few specimens were taken by sweeping and in pitfall traps on the top of The Mound.

Ozyptila (Oxyptila) praticola (C. L. Koch, 1937)

Not recorded by Bristowe. During this survey two specimens were found on the slopes of The Mound in long grass in August 1995.

Philodromidae

Philodromus aureolus (Clerck, 1757)

Not recorded by Bristowe; during this survey it was swept from lower branches and bushes in some abundance.

Philodromus cespitum (Walckenaer, 1802)

Not recorded by Bristowe; during this survey a single male was swept from long grass near the Tennis Court in May 1998.

Philodromus dispar Walckenaer, 1825

Not recorded by Bristowe. A common species in London today, but apparently very scarce in the Garden. During this survey only two females were found, in the Malaise trap.

* *Tibellus oblongus* (Walckenaer, 1802)

'Common in one area near The Lake' (Bristowe), but during this survey only a single immature female was found in the Malaise trap. A species that prefers long grass or reeds, it may have been a casualty of increased mowing and disturbance around The Lake.

Salticidae

* *Salticus scenicus* (Clerck, 1757)

Found on walls, especially south-facing, in the 1960s and today.

* *Euophrys frontalis* (Walckenaer, 1802)

'Common on sunny banks' according to Bristowe, and found quite commonly among grass during this survey, especially on The Mound.

Euophrys lanigera (Simon, 1871)

Not found by Bristowe, but during this survey it was found on some of the older walls, especially where these were south-facing.

Sitticus pubescens (Fabricius, 1755)
Not seen by Bristowe, and uncommon today in London. During this survey both sexes were taken on a south-facing wall near the greenhouses in The Yard.

Lycosidae

Pardosa palustris (Linnaeus, 1758)
Common today at several places in uncut grassy areas (and elsewhere in London), although apparently absent in the 1960s.

Pardosa pullata (Clerck, 1757)
Not found by Bristowe, but during this survey it was found to be abundant in many parts of the Garden, as it is in long grass in most open spaces in London.

* *Pardosa prativaga* (L.Koch, 1870)
Bristowe reported this species from a single specimen collected by Mr Bradley, and observed that it was 'definitely not established in the Garden'. Several specimens were taken during the current survey, including three trapped on the patch of grass in the flamingo enclosure where it is probably established today.

Alopecosa pulverulenta (Clerck, 1757)
Not seen by Bristowe, this large lycosid is now common in those parts of the Garden where the grass is allowed to grow long for at least part of the summer.

(*Trochosa terricola* Thorell, 1856)
'Scarce' in 1963 and surprisingly not found during this survey, although it is one of the commonest grassland spiders in the London area.

(*Pirata piraticus* (Clerck, 1757))
'The only common lycosid' according to Bristowe, who found it around the fringes of The Lake. Surprisingly, this common marshland species appears to be absent today, almost certainly a casualty of mowing and disturbance around The Lake. However, it could be reintroduced at any time with almost any water weed or marshland plant.

Pisauridae

Pisaura mirabilis (Clerck, 1757)
Not seen by Bristowe; during this survey a few specimens were trapped in long grass on The Mound. Like other larger grassland species it may need patches of grass left uncut through the winter before it will thrive in the Garden. This also applies to the Tetragnathidae and Araneidae.

Agelenidae

Tegenaria gigantea Chamberlin & Ivie 1935
Not found by Bristowe, but during this survey found among plantpots, and under Gardeners' debris in several places. Rather surprisingly, it was also trapped at sites in the flamingo enclosure and on The Mound.

(*Tegenaria atrica* C. L. Koch, 1843)
In 'outhouses' according to Bristowe; but not seen since - indeed not recorded in London at all for many years.

* *Tegenaria domestica* (Clerck, 1757)
Common in and around buildings since it was recorded by Bristowe originally in 1938; several specimens were found during the present survey.

Mimetidae

Ero furcata (Villiers, 1789)
Not seen by Bristowe but, during this survey a few specimens were trapped in the flamingo enclosure and on top of The Mound.

Theridiidae

* *Steatoda bipunctata* (Linnaeus, 1758)
Common around buildings today as during the 1960s.

Anelosimus vittatus C. L. Koch (1836)
Not found by Bristowe, but during this survey it was frequently swept from vegetation.

Achaearanea lunata (Clerck, 1757)
Not seen by Bristowe, but during this survey David Nellist found several females on webs at the base of large trees and along the wall adjacent to Constitution Hill.

(*Achaearanea tepidariorum* (C. L. Koch, 1841))
A hothouse species, first found in 1929 and restricted to a single individual in 1962, according to Bristowe. Not seen since.

* *Theridion varians* Hahn, 1833
Common on bushes and the lower branches of trees according to Bristowe; apparently less common today, but still swept from trees and bushes occasionally.

* *Theridion melanurum (denticulatum)* Hahn, 1831
Fairly common on the lower branches of trees since the 1960s.

Theridion mystaceum L. Koch 1870
Not recorded by Bristowe; during this survey several individuals were beaten from holly bushes adjacent to Constitution Hill by David Nellist.

Theridion tinctum (Walckenaer, 1802)
Not recorded by Bristowe; during this survey several females were beaten from the lower branches of trees and bushes near the Tennis Court and the Recycling Centre.

Theridion instabile O.P.-Cambridge, 1870
Not recorded by Bristowe; during this survey several specimens were swept from long grass and low bushes near the Tennis Court.

* *Theridion bimaculatum* (Linnaeus, 1767)
Only a single specimen was found by Bristowe, but it is fairly common throughout the Garden today.

Theridion pallens Blackwall, 1834
Not recorded by Bristowe, but common today on foliage especially on trees and bushes.

* *Enoplognatha ovata* (Clerck, 1757)
Frequent in long grass, now as in the 1960s.

* *Enoplognatha thoracica* (Hahn, 1833)
Common now as in the 1960s; one of only six species trapped at all four pitfall sites.

Pholcomma gibbum (Westring, 1851)
A small woodland spider which occurs even at disturbed sites (it is known from Hyde Park). It was not recorded by Bristowe, but during this survey David Nellist found two females when beating the lower branches of conifers and holly bushes near The Mound.

Nesticidae

(*Nesticus cellulanus* (Clerck, 1757))
Found by Bristowe in a damp outhouse, but not seen since.

Tetragnathidae

Tetragnatha extensa (Linnaeus, 1758)
No *Tetragnatha* species were recorded by Bristowe, but three were found during this survey. A single adult female *T. extensa* was swept from dense herbage near the north-west corner of the Garden during May 1997.

Tetragnatha montana Simon, 1874
Both sexes were swept from tall herbaceous vegetation on the north-eastern slope of The Mound during June 1997, by David Nellist.

Tetragnatha obtusa C. L. Koch, 1837
Both sexes swept from vegetation in May 1997 and June 1998, the former being one of the first records of this species for London (Milner 1998).

* *Pachygnatha clercki* Sundevall, 1823
'Amongst vegetation near The Lake' according to Bristowe; during this survey a few specimens were found in long grass near The Mound in August 1995, but otherwise this very common London species was conspicuous by its scarcity.

* *Pachygnatha degeeri* Sundevall, 1830
Very common, especially in longer grass, today as in the 1960s.

(*Metellina (Meta) segmentata*(Clerck, 1757))
'On herbs near The Lake but noticeably absent from shrubs and evergreens' according to Bristowe; during this survey none were found, although it is common elsewhere in London.

* *Zygiella x-notata* (Clerck, 1757)
Common on buildings and fences today as in the 1960s.

Araneidae

Gibbaranea gibbosa (Walckenaer, 1802)
Not recorded by Bristowe, but during this survey a few specimens were swept from dense foliage in different places.

* *Araneus diadematus* Clerck, 1757
Common in the Garden according to Bristowe, but not so frequently found today. During this survey only one pair of adults was found, on bushes near the Tennis Court by Colin Plant, in September 1995. Elsewhere in London it is common, even in the central area.

(*Larinioides sclopetarius*(Clerck, 1757))
'Common on bridges over The Lake' according to Bristowe, but not seen since.

Nuctenea umbratica (Clerck, 1757)
Not recorded by Bristowe, but during this survey a single mature female was found on a web on the Indian Bean Tree near The Lake in map square H9.

* *Araniella* (*Araneus*) *cucurbitina* (Clerck, 1757)
'Several on deciduous shrubs' according to Bristowe; during this survey in 1998 several individuals were swept from trees and bushes near the Tennis Court by David Nellist.

Araniella (*Araneus*) *opisthographa* (Kulczynski, 1905)
Not recorded by Bristowe: during this survey a single female was swept from bushes near the Tennis Court in May 1997.

Zilla diodia (Walckenaer, 1802)
In May 1996 a single male of this Nationally Notable (Nb) species was found near The Yard. This species does not otherwise occur in London and the nearest site is probably Burnham Beeches, Buckinghamshire — a large expanse of ancient wood pasture and woodland. Unless further specimens are found, this example must be regarded as an isolated introduction, probably imported into the Garden on bushy plants.

Linyphiidae

Although the Linyphiidae (money spiders) is the major family of British spiders with over 40 per cent of all species, it was poorly represented in Bristowe's 1964 list. He recorded just 17 species — mainly ubiquitous species or pioneers. Many of these species are very small and some are difficult to find. During this survey, various searches and in particular the pitfall-trapping, has augmented this list considerably, but it is likely that several of the new additions were present earlier and had been overlooked.

Walckenaeria acuminata Blackwall, 1833
Not recorded by Bristowe; during this survey this species was found to be fairly common and was trapped on The Mound.

Walckenaeria antica (Wider, 1834)
Not recorded by Bristowe: during this survey found to be slightly commoner than *W. acuminata* in grass on The Mound.

Walckenaeria atrotibialis (O.P.-Cambridge, 1876)
Not recorded by Bristowe: during this survey two females were trapped at site D on the slope of The Mound in August.

?**Dicymbium brevisetosum* Locket, 1962 (originally reported as *Dicymbium nigrum* (Blackwall, 1833)
These two species were separated in 1962, but the females are indistinguishable. Bristowe recorded a single female, but as no males of *D. nigrum sensu stricto* have yet been found

anywhere in London county, it is probable that his specimen was *D. brevisetosum*. During the present survey, one male *D. brevisetosum* and two females (assumed to be the same species) were trapped at sites C and D on The Mound.

(*Entelecara erythropus* (Westring, 1851))
'Several amongst vegetation' according to Bristowe; and reported by Savory and Le Gros earlier (1957), but not seen during the present survey.

(*Gnathonarium dentatum* (Wider, 1834))
A fairly common marshland and pond-fringe species throughout London. Bristowe reported several amongst vegetation around The Lake. The fact that this species is now apparently absent is almost certainly due to the regular mowing of the lakeside vegetation.

Maso sundevalli (Westring, 1851)
A woodland litter species, not recorded by Bristowe. During this survey two males were trapped on The Mound in June 1996.

Pocadicnemis juncea Locket & Millidge, 1953
A common grassland species in London, but not recorded by Bristowe. During this survey two female were trapped on top of The Mound.

* *Oedothorax fuscus* (Blackwall, 1834)
A common pioneer species. 'A few specimens' were found by Bristowe, and similarly one or two specimens were found in the present survey at each of the trap sites.

* *Oedothorax retusus* (Westring, 1851)
'Common amongst vegetation' according to Bristowe; during this survey a few specimens were trapped in the flamingo enclosuré and on The Mound.

Trichopterna thorelli (Westring, 1861)
Not recorded by Bristowe. During this survey a single male was found in The Yard among dead leaves in June 1997. This is the only record of the species in London and must be thought of as an isolated importation to the Garden.

Tiso vagans (Blackwall, 1834)
Not recorded by Bristowe; during this survey a few specimens were trapped on The Mound, and one near The Lake.

Monocephalus fuscipes (Blackwall, 1836)
A woodland species often found in disturbed habitats. Not recorded by Bristowe; during this survey it was found quite commonly among grass on The Mound and two specimens were trapped near The Lake.

Gongylidiellum vivum (O.P.-Cambridge, 1875)
A common spider in short grass around London. Not recorded by Bristowe; during this survey a single specimen was trapped in the flamingo enclosure.

Micrargus herbigradus (Blackwall, 1854)
A common spider of grassland and woodland in London. Not recorded by Bristowe; during this survey a few individuals were trapped on The Mound and in the flamingo enclosure.

Micrargus subaequalis (Westring, 1851)
Not recorded by Bristowe, and not a common spider in London, but during this survey it was trapped at all four pitfall sites and was common among grass in several parts of the Garden.

Erigonella hiemalis (Blackwall, 1841)
Not recorded by Bristowe, but during this survey it was found quite commonly on The Mound.

(*Savignia frontata* (Blackwall, 1873))
A pioneer species and frequent aeronaut, quite common in London although its appearance is quite unpredictable. A single specimen was collected by Bristowe, but it has not been seen in the Garden since.

* *Diplocephalus cristatus* (Blackwall, 1833)
'Common amongst vegetation' according to Bristowe, but not at all common anywhere in London today. During this survey, Colin Plant found two specimens in grass, on the north side of the Garden.

Diplocephalus latifrons (O.P.-Cambridge, 1868)
A species of disturbed woodland common throughout London. It was not recorded by Bristowe, but during this survey it was found to be common throughout the Garden.

Diplocephalus picinus (Blackwall, 1841)
One of the commonest species in London, but not recorded by Bristowe, and during this survey only three specimens were found in grass near The Lake.

Panamomops sulcifrons (Wider, 1834)
This tiny species, the 'horned spider', is fairly common throughout London. It was not recorded by Bristowe, but during this survey several specimens were trapped at sites on The Mound, in the flamingo enclosure and near The Lake.

Milleriana inerrans (O.P.-Cambridge, 1886)
A pioneer species common in agricultural land and widely distributed in London. Not recorded by Bristowe, but found among grass in several parts of the Garden during this survey.

* *Erigone dentipalpis* (Wider, 1834)
Very common in the Garden since the 1960s, as it is throughout London.

* *Erigone atra* Blackwall, 1833
Common in the Garden since the 1960s, as it is throughout London.

Porrhomma errans (Blackwall, 1841)
A rare (Notable — Nb) linyphiid, not previously recorded in London. A single female was trapped on the south-eastern slope of The Mound in November 1995.

* *Meioneta rurestris* (C. L. Koch, 1836)
A very common species among grass throughout London and found frequently in the Garden both in the 1960s and today.

Meioneta saxatilis (Blackwall, 1844)
During this survey it was found to be very common throughout the Garden, but strangely it is absent from Bristowe's list.

(*Meioneta beata* (O.P.-Cambridge, 1906))
Recorded by Bristowe, but not seen since.

Microneta viaria (Blackwall, 1841)
Very common in the Garden today, but strangely not found by Bristowe.

Centromerus sylvaticus (Blackwall, 1841)
A winter-active, woodland species, common throughout London. Not recorded by Bristowe; during this survey a single male was trapped on top of The Mound in January 1997.

Centromerus dilutus (O.P.-Cambridge, 1876)
A tiny woodland species, not very commonly found in London. Not recorded by Bristowe, but during this survey a single male was trapped inside the flamingo enclosure in May 1997.

Centromerita bicolor (Blackwall, 1833)
A winter-active species not recorded by Bristowe, but found very commonly throughout the grassy areas of the Garden mainly from November to March.

Macrargus rufus (Wider, 1834)
A very common London species, yet not recorded by Bristowe. During this survey three individuals were trapped on the top of The Mound, mostly during the winter months.

Bathyphantes gracilis (Blackwall, 1841)
This species is a real mystery. It is the second most common ground-living species in London (Milner, in press), a disturbed ground specialist and pioneer, yet it was not recorded by Bristowe. During this survey it was found in small numbers in most parts of the Garden, but only trapped at the two low-lying sites — near The Lake and inside the flamingo enclosure.

Tapinopa longidens (Wider, 1834)
Not recorded by Bristowe, but during this survey it was found to be fairly common in late summer and autumn; trapped at both sites on The Mound and by The Lake.

Stemonyphantes lineatus (Linnaeus, 1758)
Not recorded by Bristowe; during this survey it was found occasionally among longer grass in several parts of the Garden.

* *Lepthyphantes leprosus* (Ohlert, 1865)

Recorded by Bristowe (a single specimen); during this survey a few individuals were found by David Nellist among dead leaves at the base of trees along the wall facing Constitution Hill, and among plant pots in The Yard.

Lepthyphantes minutus (Blackwall, 1833)

Not recorded by Bristowe; during this survey a few specimens were taken around the base of trees in the wooded areas on The Mound.

Lepthyphantes obscurus (Blackwall, 1841)

A rare spider in London, only known from one other site (Hampstead Heath). Not recorded by Bristowe, but during this survey a single female was beaten from heather overhanging the main path in July 1998 by David Nellist.

* *Lepthyphantes tenuis* (Blackwall, 1852)

'Scarce' according to Bristowe, but during this survey found to be one of the commonest and most abundant species in the Garden, as it is throughout London.

Lepthyphantes zimmermanni Bertkau, 1890

A very common spider especially in London woodlands. 'Scarce' according to Bristowe, and during this survey also found to be scarce, but a few individuals were trapped on The Mound and by The Lake.

Lepthyphantes mengei Kulczinski, 1887

Not recorded by Bristowe; during this survey a few specimens were trapped on top of The Mound and by The Lake.

Lepthyphantes flavipes (Blackwall, 1854)

Not recorded by Bristowe, surprisingly; during this survey it was found commonly in most parts of the Garden.

Lepthyphantes ericaeus (Blackwall, 1853)

Not recorded by Bristowe; during this survey occasion specimens were found at all the pitfall sites and elsewhere among grass and other low vegetation.

Lepthyphantes pallidus (O.P.-Cambridge, 1876)

Not recorded by Bristowe; during this survey a few specimens were trapped on The Mound and by The Lake.

Linyphia triangularis (Clerck, 1757)

Not found by Bristowe, but together with the following four species was predicted to be present. During this survey, it was found on bushes, with its characteristic sheet-web, in various parts of the Garden. A few individuals were also trapped on The Mound.

Linyphia hortensis Sundevall, 1830

A few specimens trapped at both sites on The Mound.

Linyphia montana (Clerck, 1757)

Two specimens were trapped — by The Lake and on The Mound.

Linyphia clathrata Sundevall, 1830

Occasionally found in most parts of the Garden.

Linyphia peltata Wider, 1834

Two individuals trapped near The Lake.

PSEUDOSCORPIONES

Neobisiidae

(*Neobisium muscorum* (Leach, 1817))

A single specimen was collected from dead leaves by Bristowe.

Roncus lubricus L. Koch 1873

A single specimen was trapped in mossy grass on top of The Mound in January 1997. It is typically found in leaf-litter.

OPILIONES

Apart from *Leiobunum blackwalli*, all records of harvestmen were made by Colin Plant from the Malaise trap operating on The Mound or from his own pitfall traps, the positions of which are indicated in the map on pages 2 and 3. These were identified by Peter Harvey. Several samples from the Malaise trap remain unidentified at December 1999.

Phalangiidae

Paroligolophus agrestis (Meade, 1855)

Frequent in the Malaise trap samples between 22 September and 20 December 1995 and again from 15 August to 5 September 1996 and evidently common here.

* *Phalangium opilio* Linnaeus, 1758

This was the only harvestman recorded by Bristowe who noted it was 'common near The Lake'. During this survey specimens were found in the Malaise trap from 27 July to 20 November 1995 and then again from 15 August to 5 September 1996, with later samples still unsorted.

Opilio saxatilis C. L. Koch, 1839

A few were found in the Malaise trap sample for 27 July to 3 August 1995.

Leiobunidae

Dicranopalpus ramosus (Simon, 1909)

Several examples of this relatively scarce species were in the Malaise trap samples from 20 November to 20 December 1995 and for 20 December 1995 to 20 February 1996, though several further samples are still to be sorted.

Leiobunum rotundum (Latreille, 1798)

Quite frequent in Malaise samples for 27 July to 3 August and 15 August to 5 September, 1995.

Leiobunum blackwalli Meade, 1861

A few were swept from vegetation on The Mound by Colin Plant on 7 July 1995.

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Collembola from Buckingham Palace Garden

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Abstract

Collembola were recorded from 1995 to 1997 at Buckingham Palace Garden. Five field visits were made in 1996 and 1997 and sampling was carried out by searching in likely places with a pooter and by collection and examination of soil and litter samples. Extraction from soil and litter samples was achieved using Tullgren funnels. Some material from a Malaise trap from 1995 was also examined. The total number of species recorded was 23, though this figure is approximate because of the uncertain taxonomy of some species. An earlier survey, in 1962 and 1963, recorded approximately 36 species of which six were not recorded in the present survey. The overall list for Buckingham Palace Garden from both surveys records a combined total of 42 species. The collembolan fauna for the Garden is discussed and is considered to remain under-recorded.

Summary of methodology

Three methods were used to retrieve Collembola from the Garden:

1 Active searching for Collembola and collecting the individuals with a pooter. The locations studied were those which appeared to be the most promising from previous experience of similar searches on other sites.

2 Removing samples of soil and other organic substrates, and placing these in Tullgren funnels. As before, the locations for each sample were those which appeared to be the most promising. The Tullgren funnels used were of a very simple design, relying on natural drying of the substrate without any artificial heat source being supplied. No data are available on how efficient these funnels are, although it is likely that only a percentage of the Collembola were extracted. It is possible that some species present in the samples were not extracted at all.

3 Samples from the Malaise trap, which operated in the Garden for the full length of the 1995–1997 survey were sorted by Colin Plant and these included some Collembola which were passed to me.

Results

The total number of individual collembolans found in the Malaise trap was 247, whilst 4,402 were collected from soil and litter samples. The total number of individuals found using the pooter was not recorded. Twenty-three species were found in total, of which twenty-two were extracted from the Tullgren funnels. Eight were found using the pooter, of which one was not found by the funnels, and just one species was found in the Malaise trap samples, this species being also found in the funnels and with the pooter. The totals should be taken as approximate because of the uncertain taxonomy of many of the species. In the species list I have indicated where, in my opinion, the taxonomy is in doubt.

Discussion

The Collembola of Buckingham Palace Garden were previously surveyed by Peter Lawrence in 1962 and 1963 (Lawrence 1964). That survey found approximately 6,000 Collembola of approximately 36 species. Tullgren funnels only were used in his survey and a total of 78 half-litre samples were examined. This gives a density, approximately, of 154 Collembola extracted per litre of soil and a species density of just under one species per litre. It is considered that the extraction funnels used by Lawrence were probably not 100 per cent efficient either.

In the present survey, the funnels produced 4,402 Collembola of about 22 species from 159 samples, each approximately one litre in volume. This gives a much lower density of approximately 28 Collembola extracted per one litre of substrate and a species density of only about 0.14 species per litre of substrate.

The difference in the number of Collembola specimens extracted was probably due principally to differences in the design of the funnels, though it is also possible that Lawrence took samples from more 'Collembola-rich' parts of the Garden. It is also possible that numbers of Collembola have declined since the original survey, either as part of the natural cycle or perhaps as a consequence of changes in climate.

The difference in the total number of species found by Tullgren extraction (36 in the earlier survey compared with 22 in the present study) is, however, much less and is likely to be a reflection of the much larger number of samples taken from a wider variety of habitats in the more-recent work.

Of the 36 species recorded by Lawrence, 18 are not represented in the present survey whilst of the 23 species I recorded, six were absent from the earlier work. This gives a combined total of 42 species. It is quite likely, however, that most of these species were present when both surveys were made and equally probable that neither sample covered all the species present.

At the time of writing there exists no proper record of the distribution of Collembola in Britain. No national check-list has been produced since Kloet and Hincks (1964). It is therefore not possible to provide any meaningful comparison of these records with sites elsewhere, although the combined total for both surveys of around 42 species is probably more than would normally be found in a completely natural environment of the same size.

In the previous survey, Lawrence recorded *Onychiurus sinensis* from the greenhouse; this species has been recorded elsewhere in Britain only from the Royal Botanic Gardens at Kew, Surrey. Where the greenhouse stood is now a car park. Samples from nearby soil and flowerpot humus (including in the new greenhouse a few yards away), have failed to produce any of this species and it is probable, therefore, that this species is now extinct in the Garden.

List of Collembola recorded from Buckingham Palace Garden

For species recorded in the present survey information on the extraction method is given, followed by the grid squares in which the species was found. Extraction/collection methods are abbreviated as follows:

t = Tullgren funnel
p = pooter
m = Malaise trap

Thus, a species extracted by Tullgren funnel from grid square E5 is annotated t-E5. For interpretation of the grid squares refer to the main map in this *Supplement*.

?? indicates an uncertain taxonomy, rendering the given identification tentative.

Taxa recorded in the earlier survey (Lawrence 1964), but not during the current project, are included in the species list in parentheses. Taxa recorded in both surveys are annotated with an asterisk. Remaining taxa were recorded in the 1995–1997 survey only.

COLLEMBOLA

(**Hypogastruridae**)
(*Hypogastrura denticulata* Bagnall).
(*Hypogastrura gibbosa* Bagnall).
(*Hypogastrura manubialis* group ??) The taxonomy of this group is uncertain. See Christiansen (1998).

(*Xenylla grisea* group ??) The taxonomy of this group is uncertain.
(*Friesea mirabilis* Tullberg).
(*Brachystomella parvula* Schäffer).

(**Anuridae**)
(*Anurida pygmaea* Börner).

Neanuridae
* *Neanura muscorum* (Templeton) 10.ii.1997 (t) and 10.iii.1997 (t).

(**Onychiuridae**)
(*Onychiurus armatus* group ??). The taxonomy of the *O. armatus* group is uncertain. See Pitkin (1979, 1980) and Lawrence (1979).
(*Onychiurus sinensis* Stach ??).
(*Tullbergia catlipygos* Börner).
(*Tullbergia krausbaueri* Börner).

Isotomidae
(*Folsomia candida* group).
Folsomia candida (Willem) ?? 10.iii.1997.
Folsomia fimetaroides (Axelson) 10.iii.1997 (t). A specimen keying down to this species was found on 10 January 1997. The general dimensions of the furca did not agree with the norm for *F. fimetaroides* and this may be an aberrant member of a different species.
(*Folsomia garretti* Bagnall) ?? 1962–3.
Folsomia manolachei (Bagnall) 3.vii.1996 (t-E5).
* *Folsomia penicula* (Bagnall) ?? 3.vii.1996 (t-E5).
(*Folsomia quadioculata* Tullberg 1962–3). ?? A the time of the previous survey the distinction between *F. quadioculata* and *F. manolachei* is less clear than it is now. It is possible that the specimens named as *F. quadioculata* were, in fact, *F. manolachei* (Wetton 1987) and Devarveng (1982).
Folsomia similis (Bagnall) 10.iii.1997 (t).
(*Proisotoma minima* Absolon).
* *Proisotoma minuta* (Tullberg) 3.vii.1996 (t-A2). This species was found in the compost heap.
* *Isotoma notabilis* (Schäffer) 3.vii.1996 (t-H8, G10),18.xi.1996 (t-A2). Specimens probably belonging to this species were found in many other squares.
(*Isotoma olivacea-violacea* group 1962–3).
Isotoma olivacea (Tullberg) 18.xi.1996 ?? (t-A2). Taxonomy of the *Isotoma olivacea-violacea* group is uncertain. See Fjellberg (1979) and Leinaas (1980).
* *Isotoma viridus* (Bourlet) ?? 18.xi.1996 (t-C1). It is unclear whether there are two good species *I. viridus* and *I. anglicana* or just one species *I. viridus.* (Pomorski 1988).
(*Isotoma sensibilis*, Tullberg 1962–3).
(*Isotomurus palustris* (Müller) 1962–3).
Isotomurus palustris (Müller).
var. *palustris* (Müller) 26.iv.1996 (p-H7).
var. *maculatus* (Schäffer) - 26.iv.1996 (p-H7),3.vii.1996 (t-H8).
Both varieties were found on the shores of the lake.

Entomobryidae
* *Entomobrya albocincta* (Templeton) 3.vii.1996 (p-D6, J7). Found on ground under logs and cardboard. This species is usually found on bark.
* *Entomobrya multifasciata* (Tullberg) ?? 26.iv.1996 (p-G10, E6) 3.vii.1996 (t-H10, J10). This may be a good species or a variety of *E. nivalis.* See South (1961). Found on ground in litter. Found in many other squares.
* *Entomobrya nivalis* (Linn.) 24.iv.1996 (p-E6) 3.vii.1996 (t-E5, H10, F7), 20.xii.1995 (m, M9). This species was found on the ground using the pooter, but not as abundantly as *E. multifasiciata.* This species was the only one found in the Malaise trap.
(*Lepidocyrtus cyaneus* (Tullberg) (1962–3)).
Lepidocyrtus lignorum (Fabricius) ?? 10.ii.1997 (t-N9). Distinction from *Lepidocyrtus lanuginosus* (Gmelin) is unclear and they may be different varieties of the same species.

- * *Psuedosinella alba* (Packard) 18.xi.1996 (t-A2). One specimen was found in the compost heap. Individuals probably belonging to this species were found in many other squares.
- * *Heteromurus nitidus* (Templeton) 3.vii.1996 (t-H10, G10, F2) 18.xi.1996 (t-F1). Individuals probably belonging to this species were found in litter in many other squares.
- *Orchesella cincta* (L.) 26.iv.1996 (p-E6, G10) 3.vii.1996 (p-H10)(t-E5, J7, G6), 10.ii.1997 (t-C2), 10.iii.1997 (t-OI, H1).
- * *Orchesella villosa* (Geoffroy) 3.vii.1996 (t-H10, J10),18.xi.1996 (p-F2, G10) 10.ii.1997 (t-N9, C2, L11).

Tomoceridae

(*Tomocerus minor* Lubbock 1962–3).

Tomocerus vulgaris (Tullberg) 24.iv.1996 (p-E6),3.vii.1996 (p-H10).

Neelidae

(*Neelus minimus* Willem 1962–3).

Sminthuridae

(*Sminthurides minimus* Krausberg 1962–3).

(*Sminthurides pumilis* Krausbauer).

* *Sminthurinus elegans* (Fitch) ?? 3.vii.1996 (t-H8) .

* *Sminthurinus aureus* (Lubbock) 10.ii.1997 (d, F11).

(*Sminthurinus niger* (Lubbock) 1962–3).

Dicyrtomidae

Dicrytoma saundersi (Lubbock) 10.ii.1997 (t-C1).

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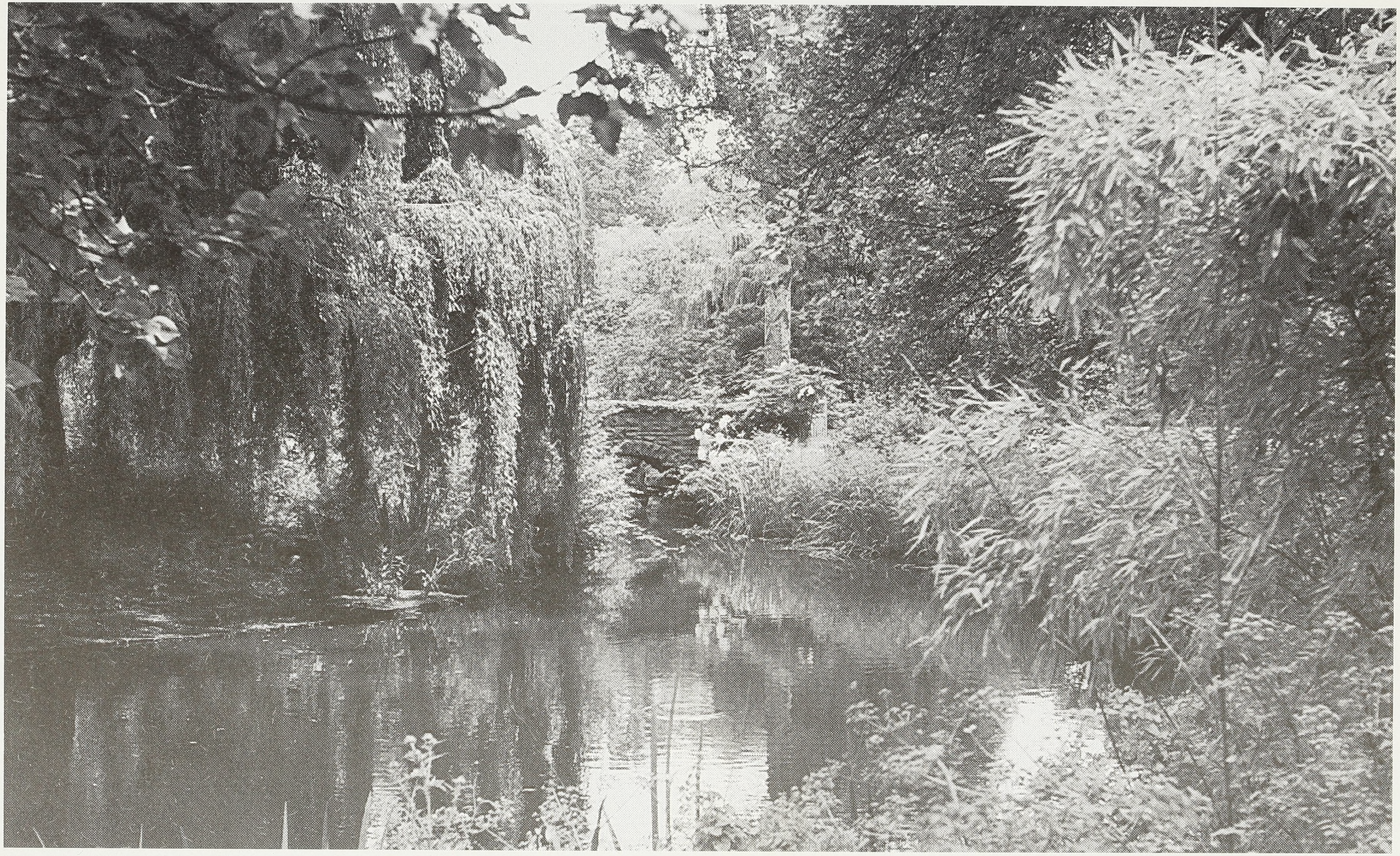

PLATE C. Buckingham Palace Garden, London. View from Mudhole towards No. 1 bridge, June 1998.

Photographed by Mark Lane.

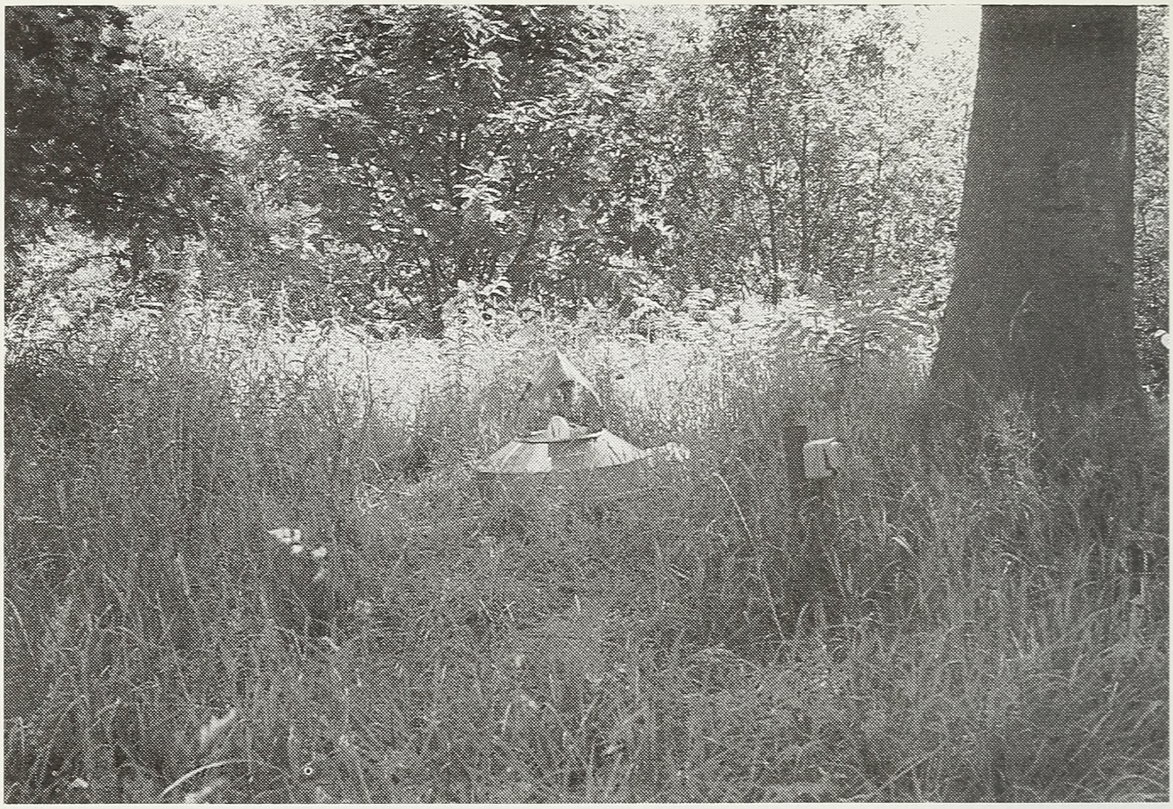

PLATE D. Buckingham Palace Garden, London. The Robinson-pattern moth trap in situ on top of The Mound, June 1998. *Photographed by Mark Lane.*

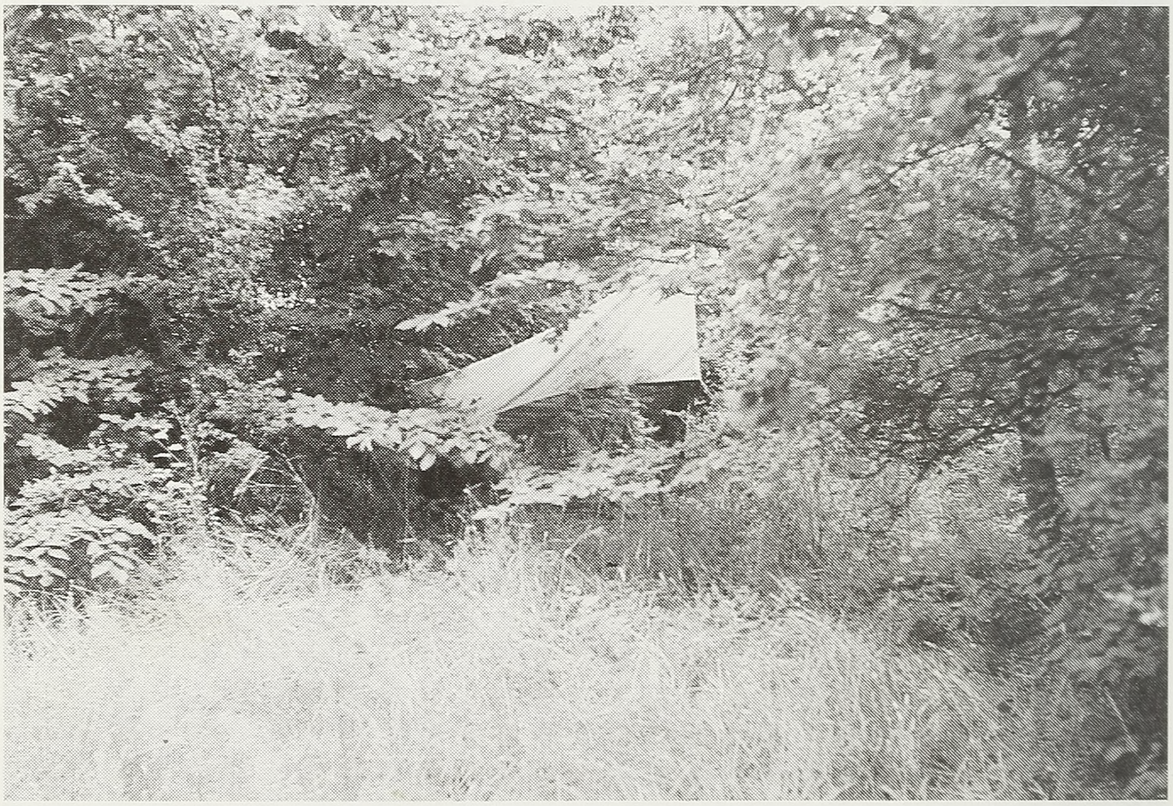

PLATE E. Buckingham Palace Garden, London. The Malaise trap, in situ on The Mound, June 1998. *Photographed by Mark Lane.*

The natural history of Buckingham Palace Garden, London. Part 1

Supplement to *The London Naturalist* No. 78

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